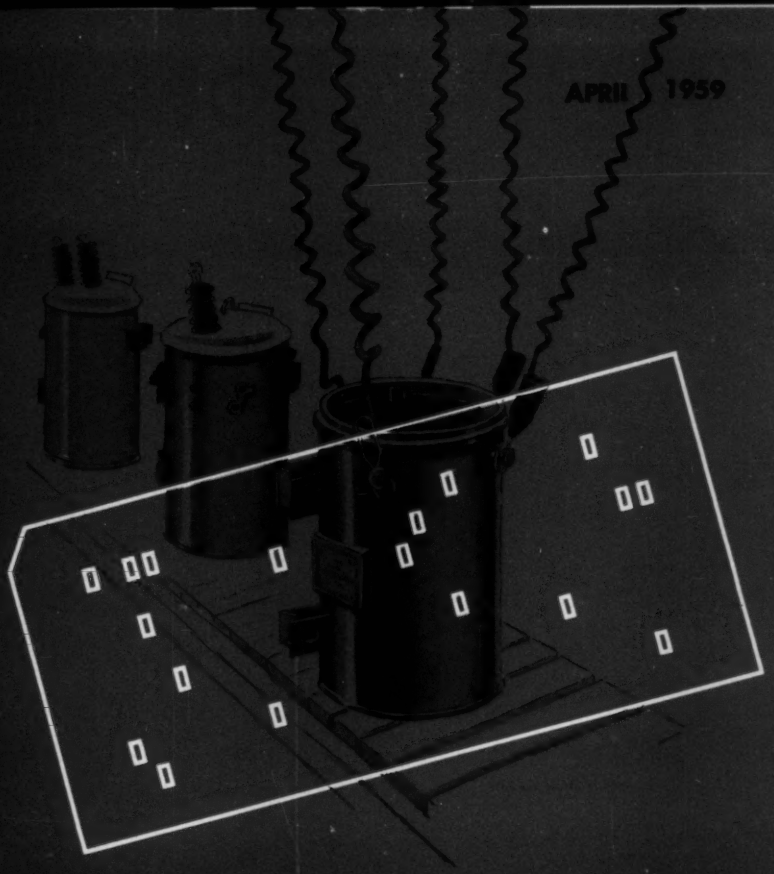
AUTOMATION

APRIL 1959



Programmed Transformer Testing

THE MAGAZINE OF AUTOMATIC MANUFACTURING OPERATIONS

- Developing Automation for Flexibility of Output
- Finishing Crankshafts for Assembly
- Numerical Control of Production Machines
- Continuous Heat Processing

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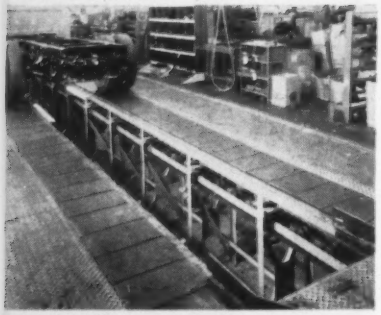

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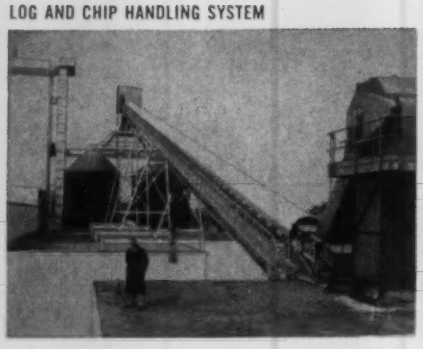

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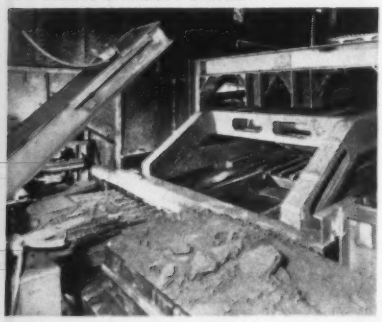

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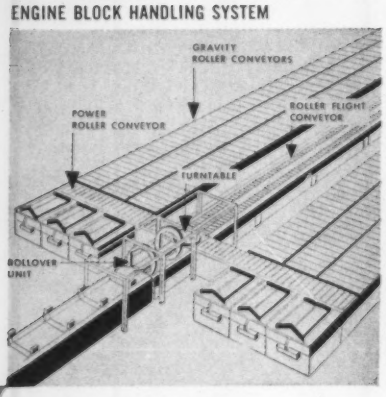
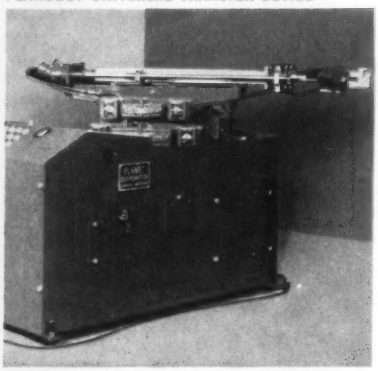


PLANOBOT UNIVERSAL TRANSFER DEVICE



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Circle 651 on Page 17

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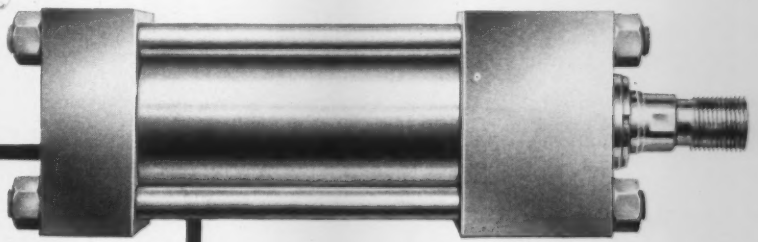

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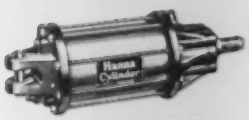

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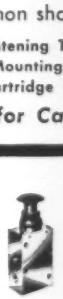

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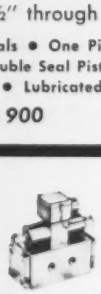

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HYDRAULIC & PNEUMATIC EQUIPMENT • CYLINDERS • VALVES

Circle 656 on Page 17

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NEW MANUAL STARTER

that challenges comparison!

CLARK BULLETIN 6002
Type "CM" MANUAL STARTER
Sizes 0 and 1

• Here is a new manual started designed to provide standards of protection and performance normally associated with magnetic starters. It can be used wherever relatively small motors (up to 7½ HP) are started across-the-line, and remote control is not required.

Compared feature by feature with other manual starters, the new Clark Type "CM" is readily recognized as the outstanding leader in its field. Some of these features are listed at the right. It is available in sizes 0 and 1, non-reversing, reversing and two-speed types, open and enclosed models.

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AUTOMATION®

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automation outlook

DEVELOPING FLEXIBLE AUTOMATION

". . . key factors in determining the ultimate success of an organized automation effort are the wise selection of personnel to work on the problem, effective use of engineering talents on various phases of the problem, and a clear, methodical approach toward its solution. . ."—*Keith B. Bennett, project engineer, Test Equipment Engineering, International Business Machines Corp., see page 39.*

". . . in any project in which automation techniques are to be considered as a major portion of the manufacturing process, the entire scope of an operation should be studied and analyzed. . . It is usually wasteful to start engineering for technical details before the whole problem of manufacturing a product is well understood. . . "—*George Philip, project engineer, Manufacturing Research, International Business Machines Corp., see page 42.*

". . . the manufacturing engineer can be expected to design with greatest emphasis on manufacturability. The product design engineer will be primarily interested in satisfying functional requirements. Combining designs developed under these two outlooks can result in a highly effective single design. . ."—*Alfred H. Johnson, project engineer, Manufacturing Research, International Business Machines Corp., see page 45.*

". . . in this era of automation, there is a definite trend towards a closer relationship between product designing and product manufacturing. This trend is being brought about by the use of automated design records which are generated on computers and data processing equipment in the engineering laboratory and are transferred to the manufacturing organization for continued processing during production. . ."—*William E. Andrus Jr., mgr., Applied Computation, International Business Machines Corp., see page 48.*

". . . an automation approach to a problem must be justified in terms of final cost of product. It is usually accomplished by replacement of manual operations for purposes of extending the capability of the human operator, incorporating more activity into an operation, and increasing quality of product and consistency of that quality. . ."—*Richard D. Seiler, Tech. ass't. to the mfg. engineering mgr., International Business Machines Corp., see page 52.*

POPULAR MISCONCEPTION

". . . many people have a mental hurdle to overcome with respect to numerical control . . . the casual observer associates computers and programming people with all forms of numerical control. While he admires and views with awe the achievements to date, he may have concluded that numerical control is not for his own commercial manufacturing operations. This viewpoint, while understandable, is erroneous. The greatest field for numerical control—commercial manufacturing—will not require complicated tape making equipment nor the high degree of skill associated therewith. . ."—*Wallace E. Brainard, chief engineer, Servo Machine Tool Div., Kearny & Trecker Corp., see page 61.*

AUTOMATION

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. . . Fluid Power news

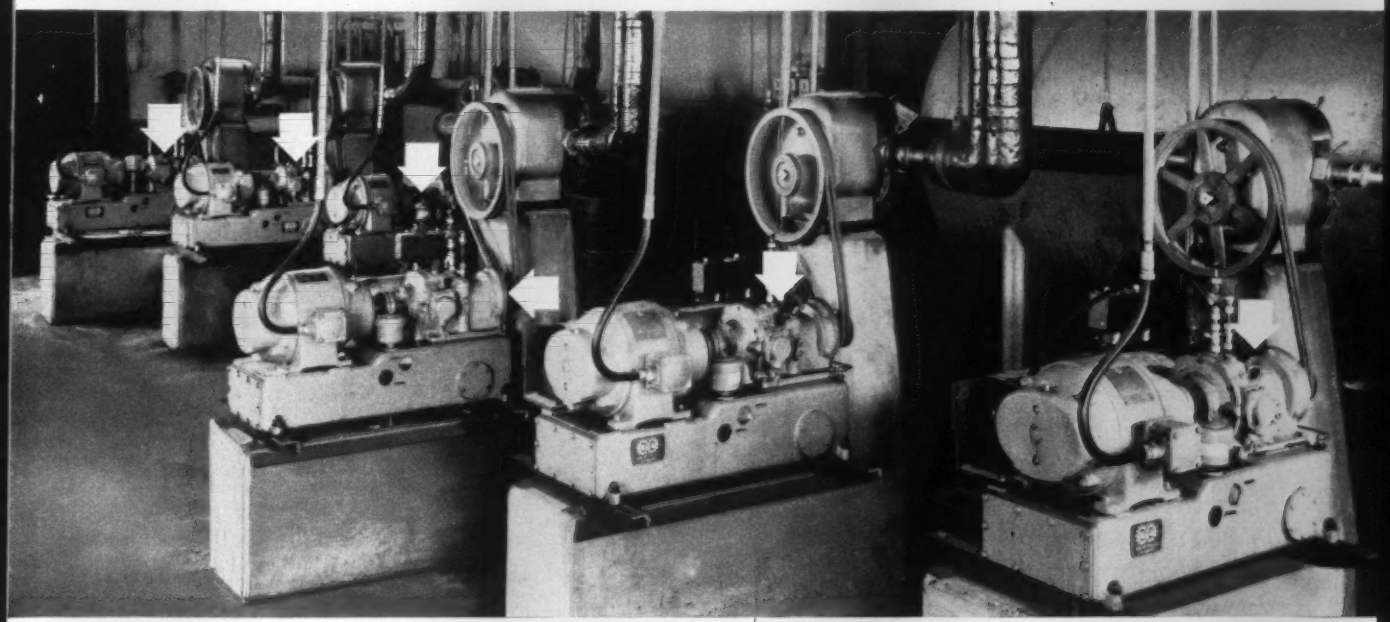
REPORT NO. 11,300 NEW LIQUID LEVEL CONTROL

From Oilgear Application-Engineering Files

HOW OILGEAR DRIVE AND CONTROL SYSTEM STABILIZED BEER FILLING LEVEL

CUSTOMER: *Large Western Brewery (Name witheld by request)*

DATA: Highly carbonated beverages must be handled gently. Throttling flow of beer into filling machine reservoirs causes foam and irregularity of liquid height, making accurate filling of cans or bottles difficult. These reservoirs are small compared to the flow through them. Costly losses are incurred on tax-paid cans "in process" due to under or overfilling. Any beer pump drive-control system must respond immediately, have smooth action, and be unaffected by daily washdowns required to maintain sanitary operations. Accurate automatic control, dependable operation, and ease of maintenance—as always—are important factors in the selection of this equipment.



SOLUTION: Shown "on the job" above, are 6 Oilgear AHB-33, two-way, "Any-Speed" transmissions driven by 3 hp electric motors, mounted on standard reservoir bases. Transmissions drive beer pumps through dual "V" belts. Beer is pumped from storage tanks to bottle or can filling machine reservoirs on the floor above. Liquid level in filling reservoirs is controlled automatically by a low pressure CO_2 signal . . . as level rises, pressure rises . . . as level falls, pressure falls. Translated to air pressure signals, which, transmitted to controls on Oilgear transmissions, automatically-instantly increase, decrease, reverse, or stop the beer pumps. Where former throttling system caused foam and irregular levels, this Oilgear system holds reservoir level to $\pm 1/16$" under continuous operation . . . assuring accurate filling of each can or bottle. Beer pumps are flushed under water pressure without disconnecting drives. Several years of continuous service have proven drives to be extremely dependable under all conditions, with little or no attention.

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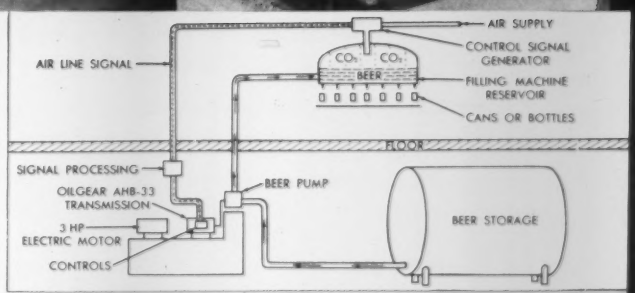
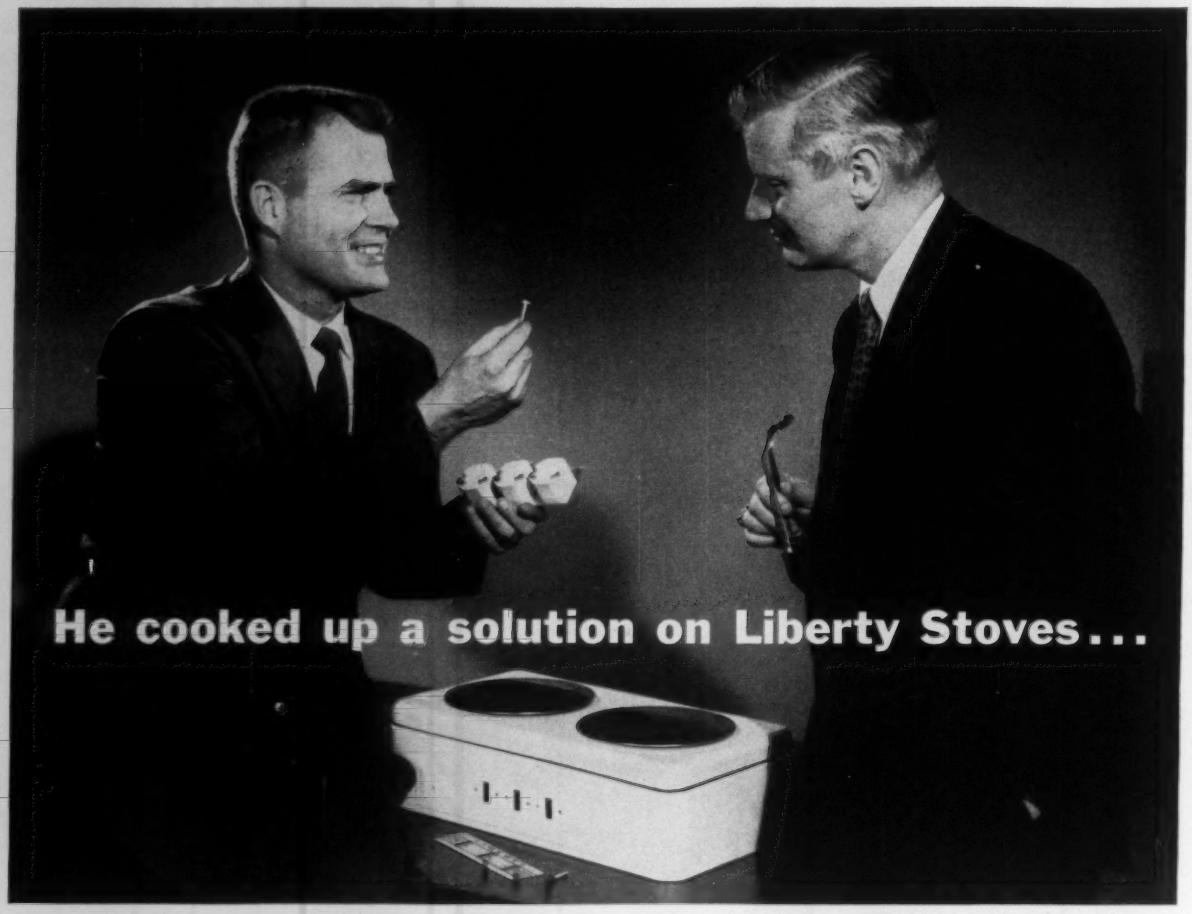


Similar Oilgear "Any-Speed" drives have improved performance on can closing, filling; paper, printing, textile, tape, and rubber processing machines; extruders, capstans, winders, stokers, centrifuges, gang-saw feeds, saw mill carriages, conveyors, and the like. They provide efficient conversion of any constant rotary motion to accurately controlled variable rotary motion . . . smooth, stepless, uniform acceleration from zero to maximum in either direction . . . manual, hydraulic, electric or electro-hydraulic controls—providing complete flexibility of location . . . low power consumption—using power only in proportion to work performed . . . durable, trouble-free, low maintenance due to simplicity and automatic lubrication of all rotating parts.



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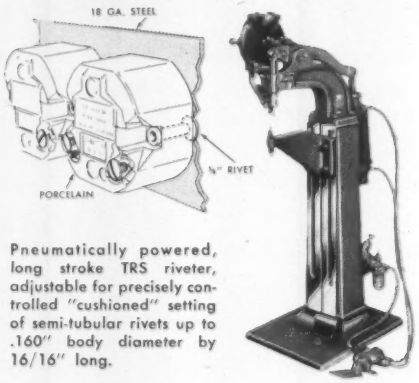

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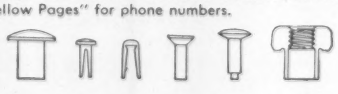

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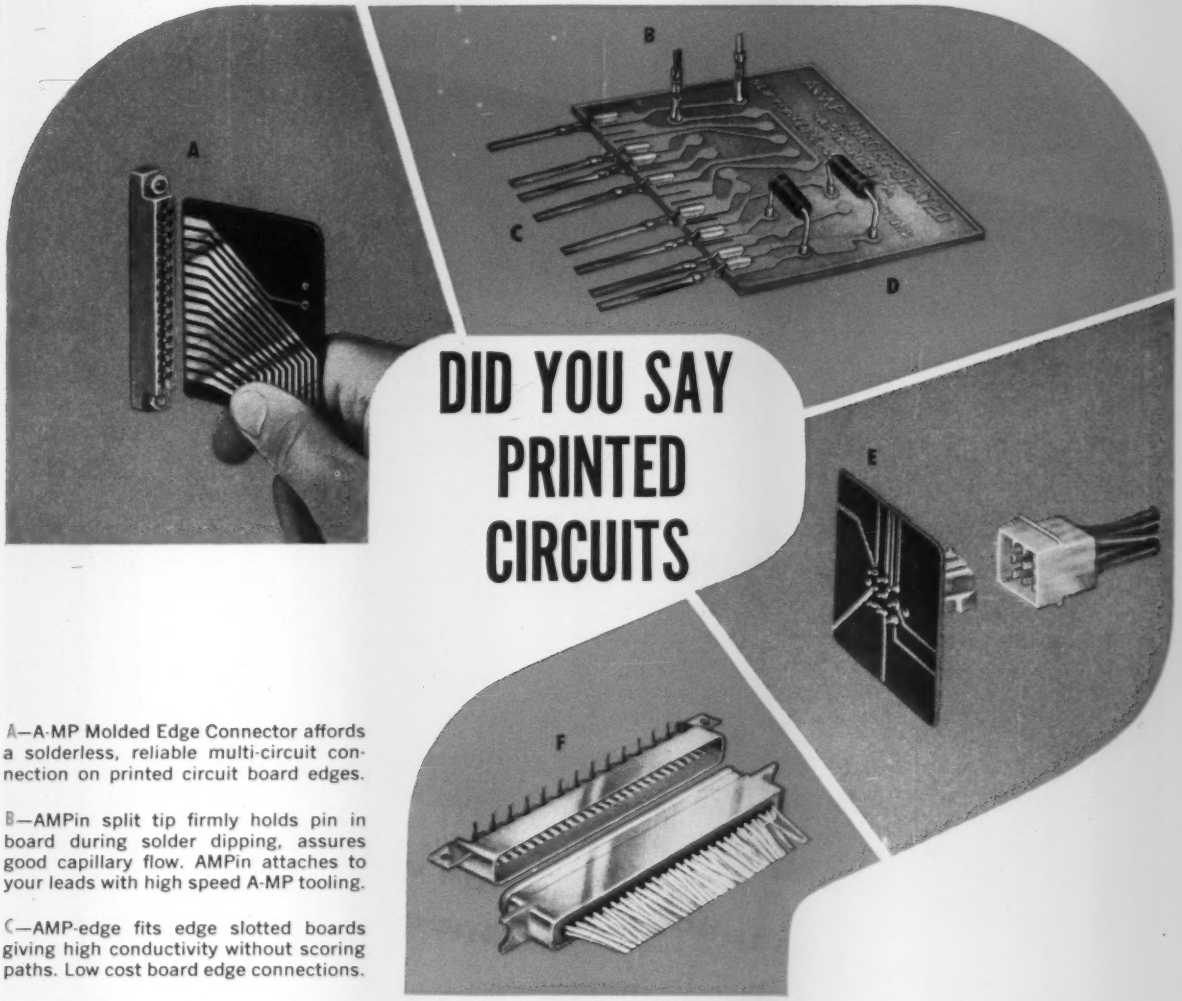

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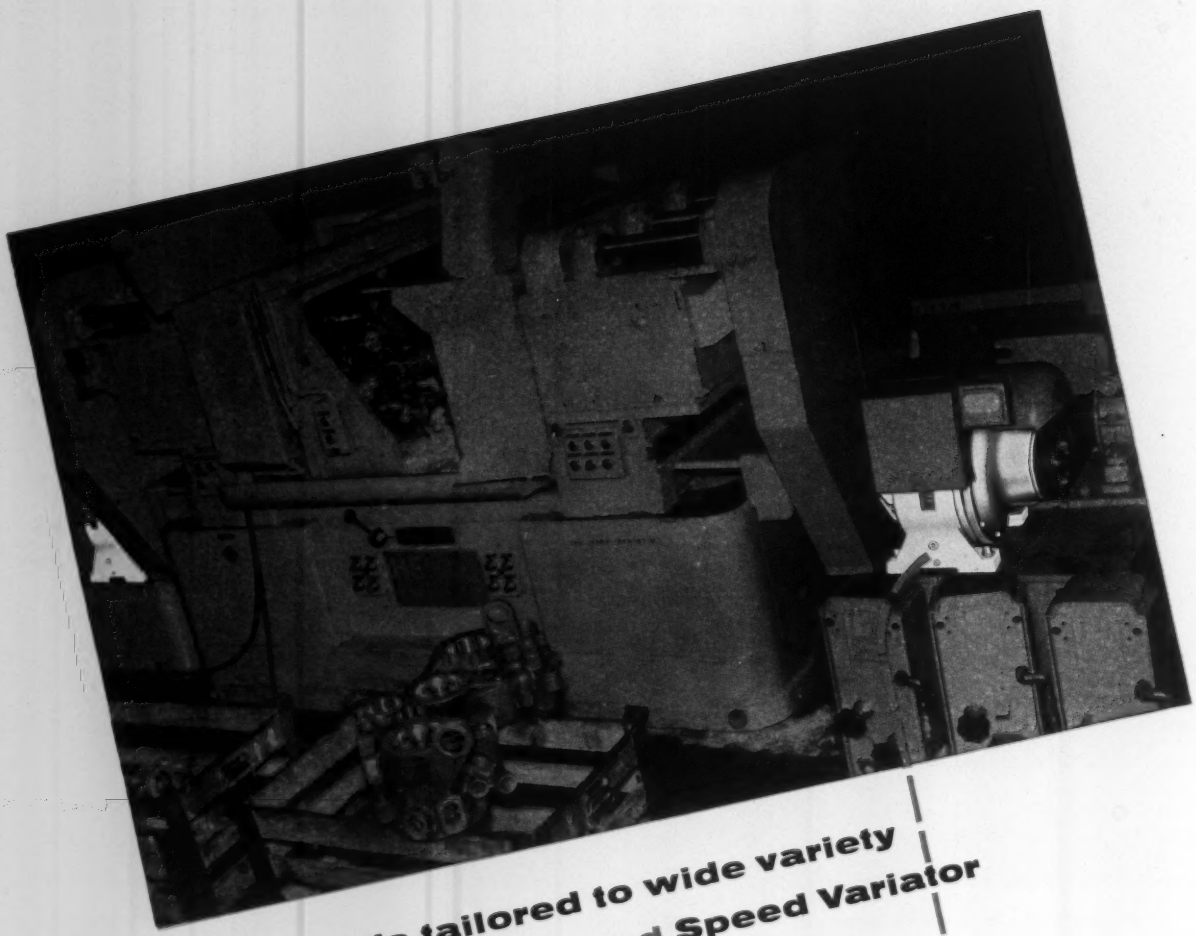

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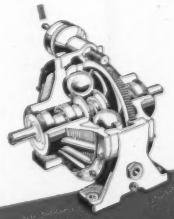
HOW IT WORKS

Power is transmitted from input shaft to output shaft through alloy steel driving balls which are in pressure contact with discs attached to the two shafts. Relative speeds of the shafts are adjusted by changing the positioning of the axles on which the balls rotate (see cutaway view, right).



CLEVELAND SPEED VARIATOR

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AUTOMATION news

Today's events and developments in the field of automation

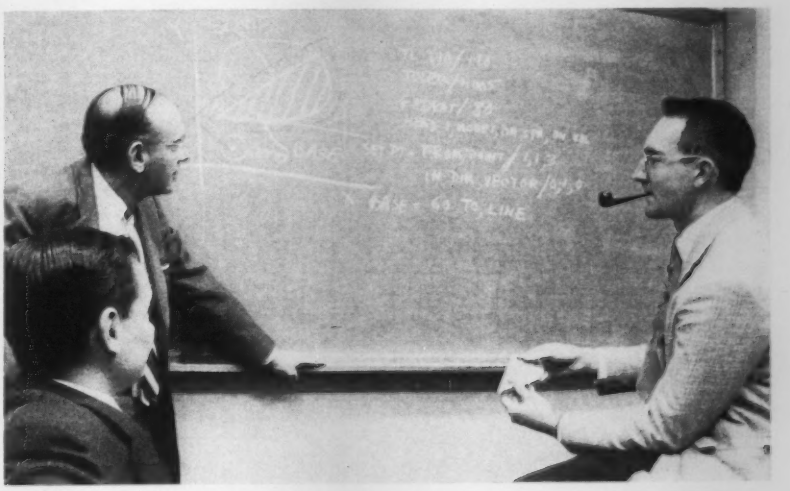
Programming Simplified for Automatic Machine Tools

NUMERICAL CONTROL for machine tools has been adopted by many plants throughout the country. The concept has saved time and money, but a bottleneck has become serious in recent years—that of preparing the instructions for the machine tool. For every new production item, a programmer must spend many hours in calculating the moves of the machine tool and in expressing these moves in numerical form for preparation of a machine control tape.

A new technique of machine tool programming has been developed at the Servomechanisms Laboratory of Massachusetts Institute of Technology in co-operation with the Air Materiel Command, U. S. Air Force, and nineteen members of the Aircraft Industries Association. Known as the APT System (Automatically Programmed Tool System), the new technique uses a master set of punched code word cards to set up a digital computer so that it will organize, calculate, and produce a tape with the numerical data necessary for machining a part from a data input consisting of a set of instruction cards. Key to the system is a relatively simple code word vocabulary with which a programmer can communicate part descriptions and cut sequences directly to the computer. This vocabulary permits people with no knowledge of computers to control complex calculations.

GEOMETRIC NAMES	PARAMETERS
POINT	TOLER
LINE	FEDRAT
CIRCLE	TL RAD
ELLIPS	TL DIA
HYPERB	CR RAD
PARAB	CR DIA
PLANE	BAL RAD
SPHERE	BAL DIA
CONE	TOOL IS
CYLNDR	
QADRIC	
VECTOR	
MOTION INSTRUCTIONS	**MISCELLANEOUS WORDS**
FROM	IN DIR
GO TO	TO
GO ON	ON
GO PAST	PAST
GO TAN	CTR
GO DELTA	AT
GO RGT	RAD OF
GO LFT	TAN TO
GO FWD	INT OF
GO BACL	MAX DP
GO BACR	Z PLANE
	DS IS
MODIFIERS	CS IS
TL LFT	PS IS
TL RGT	WITH
TL ON	ALONG
NEAR	FINI
FAR	
CUT	PLUS MACHINE TOOL
DNT CUT	DIRECTOR INSTRUCTIONS

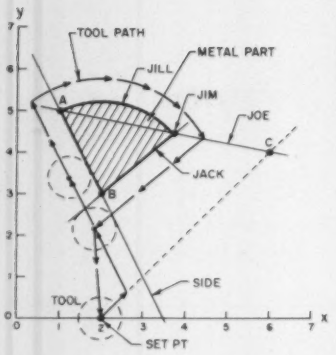
SAMPLE list of words illustrates the language of the APT System. In order to minimize computer programming, all words in the vocabulary must contain six or fewer letters or symbols, ignoring spaces.



THREE key numbers of the Servomechanisms Laboratory at Massachusetts Institute of Technology discuss a diagram involving vocabulary of the APT System. Standing at the left is Prof. J. Frank Reintjes, director of the laboratory, and on the right is Douglas T. Ross, head of the computer applications group. In the left foreground is Donald Clements, project engineer. The first demonstration of numerical control took place at M.I.T. in 1952 when an electronic device automatically operated a small milling machine.

APT is the first standardized automatic programming system that can be adapted by any company with a large computer. Although the initial system has been coded for the IBM 704 computer, the principal benefits of the system can be achieved on medium-sized, and possibly even small computers, with moderate loss of flexibility and capability. In using the system, the first step is to have a designer conceive a part. Rough sketches are then turned over to a draftsman who makes a drawing of the part. Next, a programmer uses the drawing to prepare a general outline of the machining sequence in APT code language. For example, a typical instruction would read: *ON KUL, ON SPN, GO RGT, TL LFT, CIRCLE/CTR AT, +2, +3, RADIUS, +5.* Translated, the sentence says: "Turn on coolant, turn on spindle, go right with tool on left side along the circle whose center is located at *X* equals 2, *Y* equals 3, with a radius of 5."

After the machining of the entire part has been programmed, the instructions are punched on cards which are used to feed the problem to the computer. Prior to this time, a master deck of code word program cards has been fed into the computer. When the instruction




```
A    = POINT / 1, 5
B    = POINT / 2, 3
C    = POINT / 6, 4
       TL DIA / +1.0, INCH
       FEDRAT / 30, IPM
SET PT = FROM, POINT / 2, 0
       IN DIR, POINT / C
SIDE = GO TO, LINE / THRU, A, AND, B
       WITH, TL LFT, GO LFT, ALONG / SIDE
JILL = GO RGT, ALONG, CIRCLE / WITH, CTR AT, B, THRU, A
JOE  = LINE / THRU, A, AND, C
JIM  = POINT / X LARGE, INT OF, JOE, WITH, JILL
JACK = LINE / THRU, JIM, AND, B
       GO RGT, ALONG / JACK, UNTIL, TOOL, PAST, SIDE
       GO TO / SET PT
       STOP, END, FINI
```

SAMPLE part program illustrates the simplicity of the APT System in preparing information for use in a computer. Word description of machine operations on the right is punched into cards and fed into the computer already programmed by a master deck of code word cards. Output of the computer is a tape program ready for use in a numerically controlled machine tool.

cards are fed into the computer, the master program cards set up routines which translate the APT statements into coded logical equivalent computer words; perform mathematical transformations and convert geometric definitions into canonical form; calculate successive cutting tool locations based upon the surfaces and curves defined; coordinate calculated data with other data such as tool feedrates, rapid approach and slow down, and turning on and off of coolant flow; and finally produce a tape suitable as an input to the numerical control director of the particular machine tool to be controlled.

Although the APT System, in its present state of development, has not completely eliminated the need for manual programming, a year-long period of field trials by various aircraft companies, plus research by M.I.T., has indicated that a significant portion of the parts now being manufactured can be produced using the present system. For example, a typical wing shape which required 200 manhours to program manually was programmed in 5 hours by the APT-computer method. Manhour reductions in the range of 80 to 95 per cent can be expected.

The importance of the new method of programming cannot be overemphasized, according to **Douglas T. Ross**, head of the Computer Applications Group at M.I.T.'s Servomechanisms Laboratory. Mr. Ross said, "Since the first demonstration of a numerically controlled milling machine, various improvements, including interim methods for automatic programming, have been developed. The universal nature of the APT System approach provides the technical basis for a common meeting-ground in which many techniques for using numerical control can be welded together. The continued co-operative development of the APT concept will lead to industry-wide compatibility and increased productivity from numerical control applications. Further improvements are expected to evolve from continued research, and can benefit our whole industrial economy."

The APT System has two important advantages. First, its unique language has been designed so that a standard procedure can be utilized throughout the aircraft and missile industry. Second, the system is purposely designed for future growth to accommodate more complex parts. Industry-wide testing of the system started in April, 1958, when M.I.T. provided a field trial package of approximately 8000 computer cards and 200 pages of preliminary program documentation to participating AIA companies. Other data compiled by M.I.T., consisting of six volumes totaling more than 600 pages of text, diagrams, and charts, will be released soon.

Funds for the initial research project at M.I.T. were furnished under a contract with the Air Force's Air Materiel Command. Since June of 1958, co-ordination of the project has been under the direction of AIA's Numerical Control Panel, and this group will finance the continuing development of the APT System.

Feedback Control Course Offered at Case Institute

TEN-DAY short course on numerical feedback control will be offered at Case Institute of Technology from July 6 to July 17. The course will cover the application of digital techniques to the synthesis of information handling and control circuits within a control loop.

Conducting the course will be **Dr. Harry W. Mergler**, assistant professor of Mechanical Engineering at Case Institute. It is directed toward engineers and scientists who work with guidance, control, or the generation of control functions from discrete and/or discontinuous numerical intelligence. Additional information may be obtained from **Dr. James R. Hooper Jr.**, director of Special Programs, Case Institute of Technology, Cleveland 6, Ohio.

Computer Control Applied To Vinyl Chloride Production Unit

DIGITAL COMPUTER for process control of an automated vinyl chloride monomer production unit is being installed by B. F. Goodrich Chemical Co. at its Calvert City, Ky., plant. **John R. Hoover**, president of the chemical firm, stated that the installation will be the first in the chemical processing field to use a digital system to operate a chemical process specifically designed for computer control.

An RW-300 computer, engineered by Thompson - Ramo - Wooldridge Products Co., will exercise closed loop control over the process and will log operating data and computed values. The computer will accept instrument signals, calculate and make logical decisions, and transmit signals to adjust set points of numerous controllers in the process.

According to Mr. Hoover, "By providing a degree of process control

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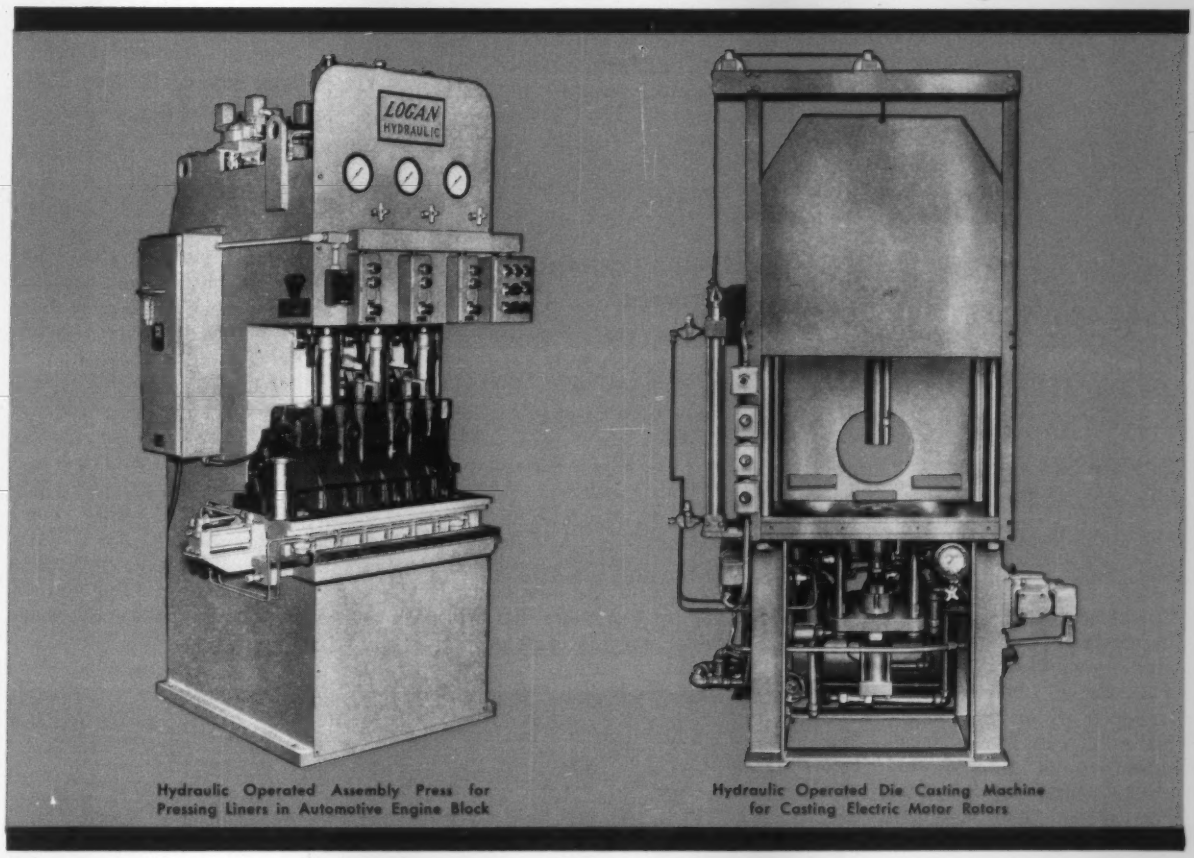

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not otherwise attainable, the new computer will maximize the efficiency of the production unit. The many variables of plant operation are continuously monitored, automatically analyzed, and the entire system adjusted to reach optimum efficiency. Investment for the computer, with its auxiliary equipment, and including installation, programming, and training of personnel will be nearly $200,000.

"The entire field of computer control has great potential benefits for many other present and new chemical processes," said Mr. Hoover. "Experience gained with the computer in operating this vinyl chloride process will be invaluable in future applications to even more complicated problems of process control." The installation is scheduled to be completed by June of this year.

Construction Ordered On First Mechanized Post Office

CONSTRUCTION of the nation's first fully mechanized mail processing plant and post office at Providence, R. I., has been ordered by **Arthur E. Summerfield,** postmaster general of the United States. The facility will be built and equipped at an estimated cost of $20 million by Intelex Systems Inc., subsidiary of International Telephone and Telegraph Corp. The Post Office Dept. will lease back the complete plant from Intelex at an annual rental of approximately $1.4 million during a 20-year lease period and also will pay maintenance costs for plant and equipment.

The Providence post office will have all the latest conveniences, including automatic stamp dispensers and open-type counters in its lobby. Mail will be moved swiftly by machine, almost never coming to a stop. Operations will be supervised from an elevated control room, which will serve as a nerve center. This center will have a visual and an electronic view of all activities, and will control conveyor movements of mail in and out of the facility.

The machinery to be installed will include devices to cull letters from larger pieces of mail and to face letters in a proper position to be canceled at high speed. Canceled letters will then be moved automatically to operators seated at keyboards which operate other machines that will sort letters according to destinations. Other automatic machinery will be used to speed the sorting of parcel post and other bulk types of mail.

The Post Office Dept. expects to run cost tests at the Providence installation to determine the efficiency and possible savings through the use of various types of mechanical equipment. Completion date of the project is scheduled for September, 1960.

Solid State Photoelectric Cell Developed

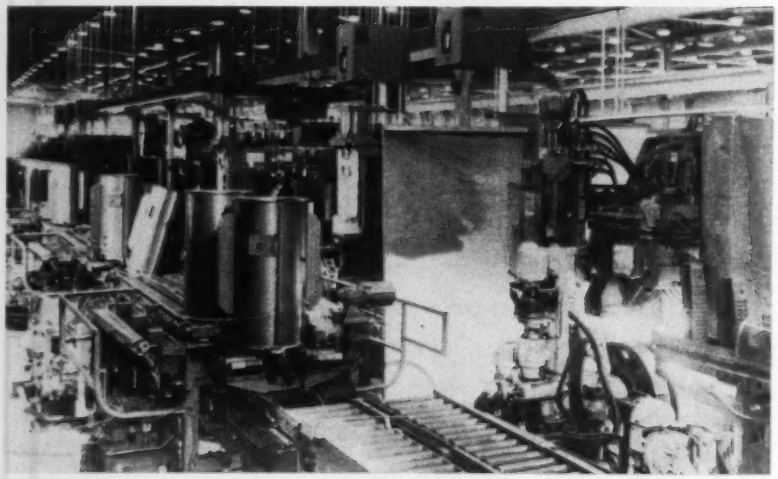
SUBMINIATURE light - sensing photo-duo-diode which is only 0.085 inch in diameter by 0.500 inch in length has been developed by Texas Instruments Inc. The diffused N-P-N diode allows current to flow when either junction is exposed to light, but effectively shuts off current in darkness. A minute glass lens admits light to the junctions.

Sensitivity of the new device, on the order of four times that of commercially available photosensitive units, and small size combine to make this unit ideal for applications such as reading data from punched card and tape systems. In darkness, the device will pass less than 0.5 microamp. When exposed to 1200 foot-candles of light, the photo-duo-diode passes up to 1200 microamps. The unit will operate equally well on either ac or dc current and any biasing voltage up to 50 volts.

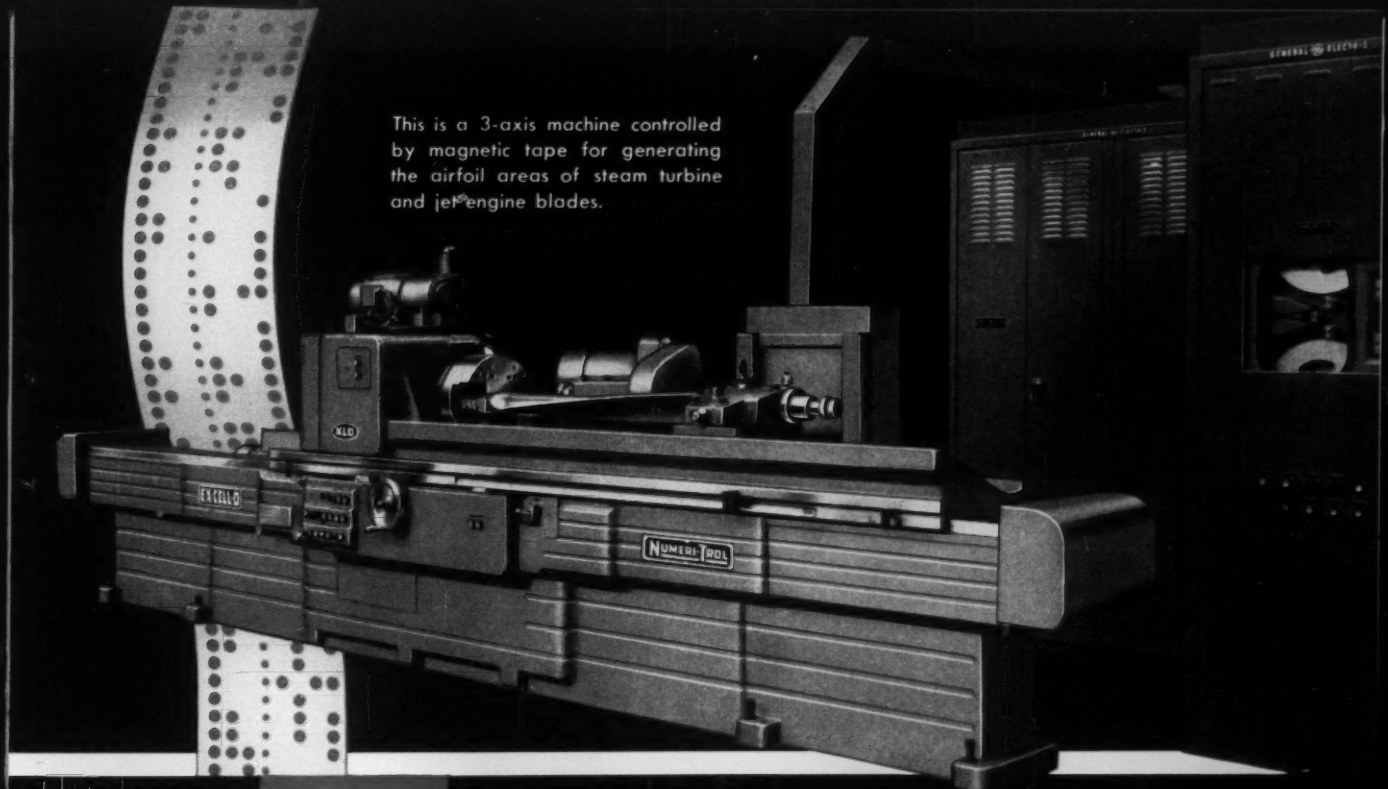
Card Programmed Rolling Mills Accepted in Steel Industry

AUTOMATIC card programmed control systems developed and built by Westinghouse Electric Corp. are being used in four reversing mills for hot rolling steel or aluminum, according to **T. R. Lawson,** manager of Westinghouse's Industrial Control Dept. Three other installations will be ready for operation in the near future.

Mr. Lawson stated that the card controlled systems, called Prodac, permit an operator to initiate a mill program by inserting a small punch-printed card into the system. Then, upon pressing a button, the mill automatically handles a hot slab, passing it through many rolling and sizing operations to produce the shape



MECHANIZED production line fabricates distribution transformer tanks at a rate of 30 per hour at a new Westinghouse Electric Corp. plant at Athens, Ga. The line includes 15 major machines integrated with 10 automatic positioners, 2 automatic turnovers, and approximately 525 feet of powered roller conveyors. The equipment was designed and furnished by National Electric Welding Machines Co. and performs 55 separate operations including arc, projection, and resistance seam welding; metal forming; marking; punching; bottom seaming; and leak testing. Other mechanized lines in the new plant handle coil winding, core manufacture, painting, assembly, and testing. Redesign of transformer elements aided in simplifying manufacturing problems and improved the core and coil performance characteristics.


This is a 3-axis machine controlled by magnetic tape for generating the airfoil areas of steam turbine and jet engine blades.
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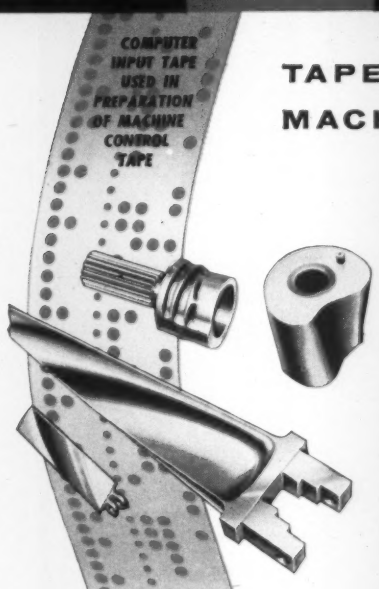
NUMERI-TROL

NUMERI-TROL

59-3

TAPE CONTROLLED PRECISION PROFILING MACHINES BY EX-CELL-O



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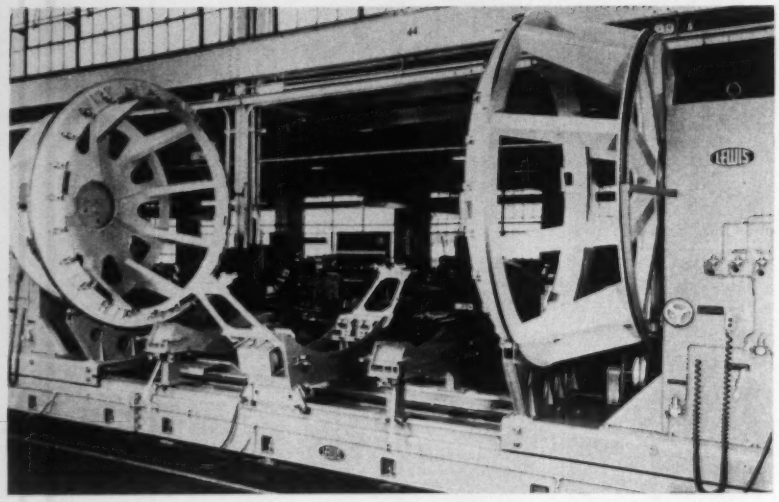
and size of material desired.

During 1958, four systems were started in operation. These included a 44-inch reversing rougher feeding a hot strip mill at Jones and Laughlin Steel Corp., a 52-inch reversing rougher at Empire Reeves Steel Corp., a 54-inch high lift blooming mill with completely automatic sequencing over rolling schedules of up to 30 passes at U. S. Steel Corp., and a 160-inch reversing mill for aluminum at Aluminum Co. of America.

An installation to begin operation in the near future will be the most extensive automatic control system yet built for the steel industry. The Prodac control system will afford automatic sequencing for a 45 by 90-inch universal slabber over rolling schedules of up to 30 passes. Information from punched cards will control screwdown, roll tables, edger opening, and manipulator and fingers for turning the steel billets, as well as direction of mill, entry speed, maximum running speed, acceleration rate, and provision for tandem rolling. This installation will be at the Gary Works of the U. S. Steel Corp. and will prepare 16-ton billets for a hot strip mill.

Other installations to be built during 1959 include a control system for a 350-hp scale-model reversing hot mill at U. S. Steel's Research Laboratories, and another for a 68-inch reversing rougher soon to be exported to Japan for a semicontinuous hot strip mill rolling carbon steel.

Westinghouse is also applying the building block approach of the Prodac systems to related processes. For example, systems using basic Prodac modules are being applied to stock house programmers, data accumulation systems for tin plate and recoil lines, and machine tools. The same principles will be applied in the future to control systems for refineries, pumping stations, and chemical processes.

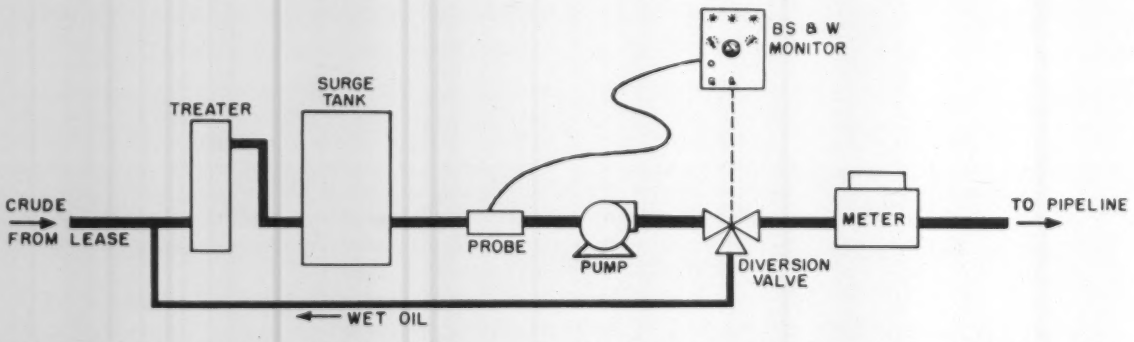


AUTOMATIC welding machine designed and manufactured by Lewis Welding and Engineering Corp. is used to weld intricate precision components for the casings of missile fuel tanks. These tanks are made of relatively thin metal sheets and include heads of either conical or elliptical shape. Two large clamp rings on movable mandrels grasp the tank components and rotate and adjust them to exacting locations as the welding and subsequent finishing operations are automatically processed. Auxiliary equipment is used to machine the edges of the formed sheets to provide the exact fit necessary for perfect welds.

Glass Making Process Eliminates Grinding & Polishing Operations

NEW PROCESS for making high grade distortion-free glass without requiring grinding and polishing has been developed by Pilkington Bros. Ltd., St. Helens, Lancashire, England. The finished product, called Float glass, is the result of 7 years' research at a cost of $11.2 million.

Although the process has been patented, many details of its operation are still not being disclosed. In



UNDER license from Gulf Research and Development Co., Fischer & Porter Co. is manufacturing and marketing a new BS&W (basic sediment & water) monitor for use in controlling excessive water in crude oil lines in LACT (lease automatic custody transfer) systems. Called Capalarm, the monitor automatically diverts oil for retreating when it is contaminated in excess of specifications. Available in a wide variety of ranges, probes (sizes and materials), and time delays, the unit is explosion-proof, weather proof, and essentially unaffected by temperature changes. Sensitivity of the system is such that oil will be diverted for retreatment when its water content changes by 0.1 per cent. The monitor is suitable for other applications where capacitance varies enough to indicate off-normal product conditions.

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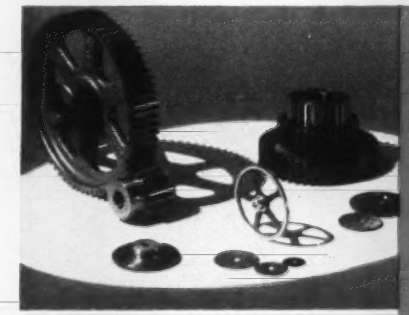
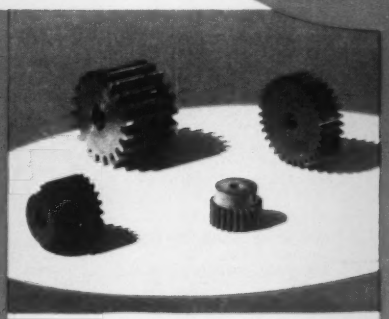
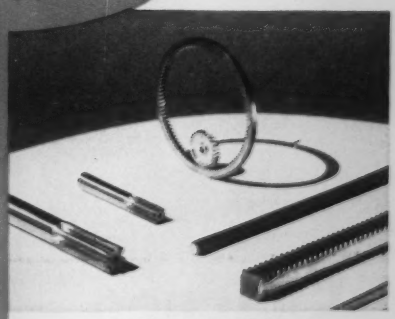


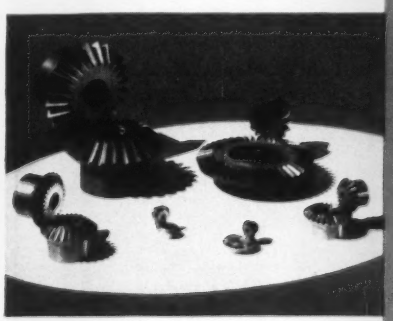
SPUR GEARS — STEEL, IRON, BRASS
14½° and 20° P.A. .208″ to 40″ P.D.



NON-METALLIC SPUR GEARS
14½° and 20° P.A. .938″ to 6.667″ P.D.

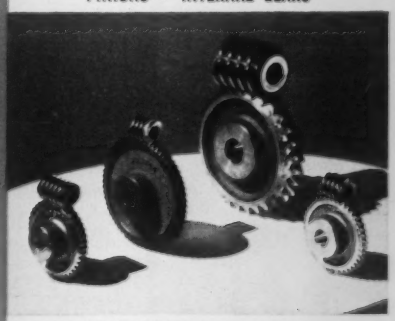


RACK • PINION WIRE
Steel and Brass 14½° and 20° P.A.
PINIONS • INTERNAL GEARS



BEVEL and MITER GEARS
Steel, Iron, and Brass 20° P.A.
.312″ to 14″ P.D.

STEEL SPIRAL MITERS 1″ to 5″ P.D.
HELICAL GEARS
Steel and Bronze .333″ to 6″ P.D.



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.417″ to 18″ P.D. **WORMS** .333″ to 4″ P.D.
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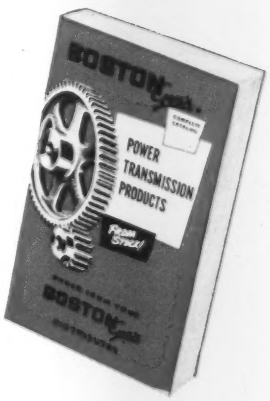

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general, the process consists of floating a continuous ribbon of hot, fluid glass from a furnace onto the surface of molten metal at a controlled temperature. The finished product emerges from the process with a brilliant, lustrous finish on both sides and is exceptionally parallel and free from distortion. No additional grinding or polishing of the glass is required.

At present the new glass is being produced in limited quantities for use in automobiles and is being marketed at plate glass prices. Later uses will include building windows, display glass, and mirrors. American interest in the new process will be handled by Pilkingtons Canada Ltd., Toronto, Canada.

Thyratron Tube Design Increases Current Rating

NEW CONCEPTS in filament and grid design allow a thirty per cent increase in peak anode current in a new series of thyratron tubes manufactured by Vacuum Tube Products Co. Inc. One of the new tubes is adaptable to any circuit employing a C6J, C6JA, 5685, or 5C21 tube and has a peak anode current rating of 100 amps compared to 77 amps for the older units. The filament of the new tube is constructed from woven

DUAL-BEAM OSCILLOSCOPE which is capable of displaying simultaneously X-Y plots and either the X or Y signal against time has been developed by Allen B. Du Mont Laboratories Inc. Instrument employs a two-gun cathode-ray tube. Each gun is independent of the other except for accelerators and pattern adjustment electrodes. Switching arrangement on the front panel develops 9 major modes of display, and, by introducing Z-axis modulation, 27 additional display modes are possible.

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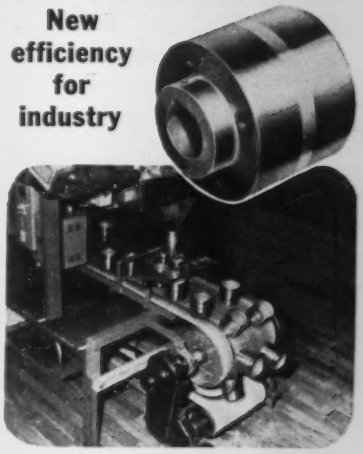

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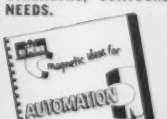

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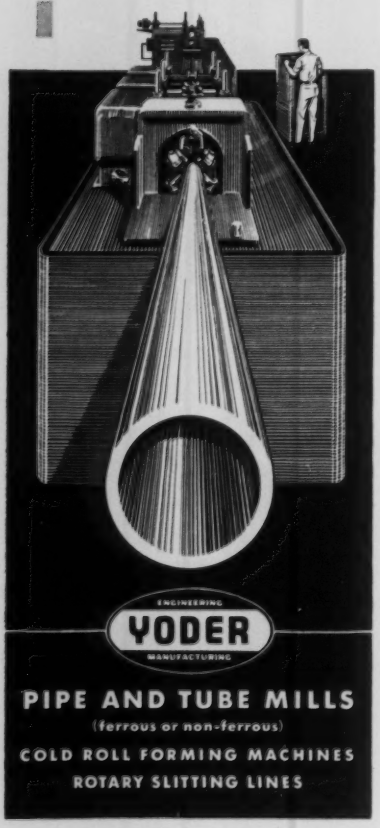

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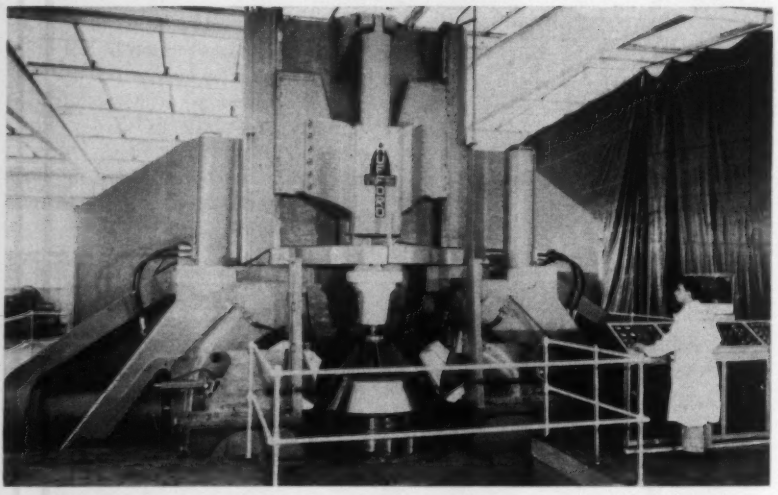


SPIN FORGE machine developed by Hufford Corp., Div., Siegler Corp., is capable of forming a 1-inch-thick piece of stainless steel into parts up to 60 inches in diameter and 10 feet in height. Metal to be formed is placed on the machine's mandrel and is held in place by a hydraulic ram that can exert 200,000 pounds of force. The mandrel is then rotated at speeds up to 400 rpm, and two hydraulically actuated tool rings, located on each side of the mandrel, force the metal over and around a center form. Control of the machine during the forming operations is maintained by an electronic tracer unit that continuously synchronizes and controls the positions of the tool rings.

mesh which replaces an electro-etched element. This design provides a large, interwoven surface for the cathode coatings, allowing a heavier oxide layer to be applied without danger of chipping. The thickness of the cathode coating stabilizes the filament temperature and minimizes the effects of strong current surges through the tube.

The power rating of any equipment using the new thyratron tubes will be automatically increased, and longer tube life can be expected. Thyratron tubes are commonly used in spot and seam welding machines to control current pulses and in rectifier systems for converting ac current to dc for running variable speed motors.

United Aircraft Offers Numerical Control Systems

EVALUATION tests are underway on two new numerical control systems which have been engineered and developed by the Data Systems Dept., Norden Div., United Aircraft Corp. Initially, only point-to-point positioning systems will be offered. Later plans call for continuous path and rotary table position systems as well as automatic inspection machines.

First to be offered will be the Decasyn system, designed and developed to compete favorably with other low cost systems. The system employs a synchro for positioning which has five windings. The point-to-point systems are applicable in any requirement where work is moved from one position to another and stopped for performance of operations such as boring, drilling, riveting, milling, or inspection.

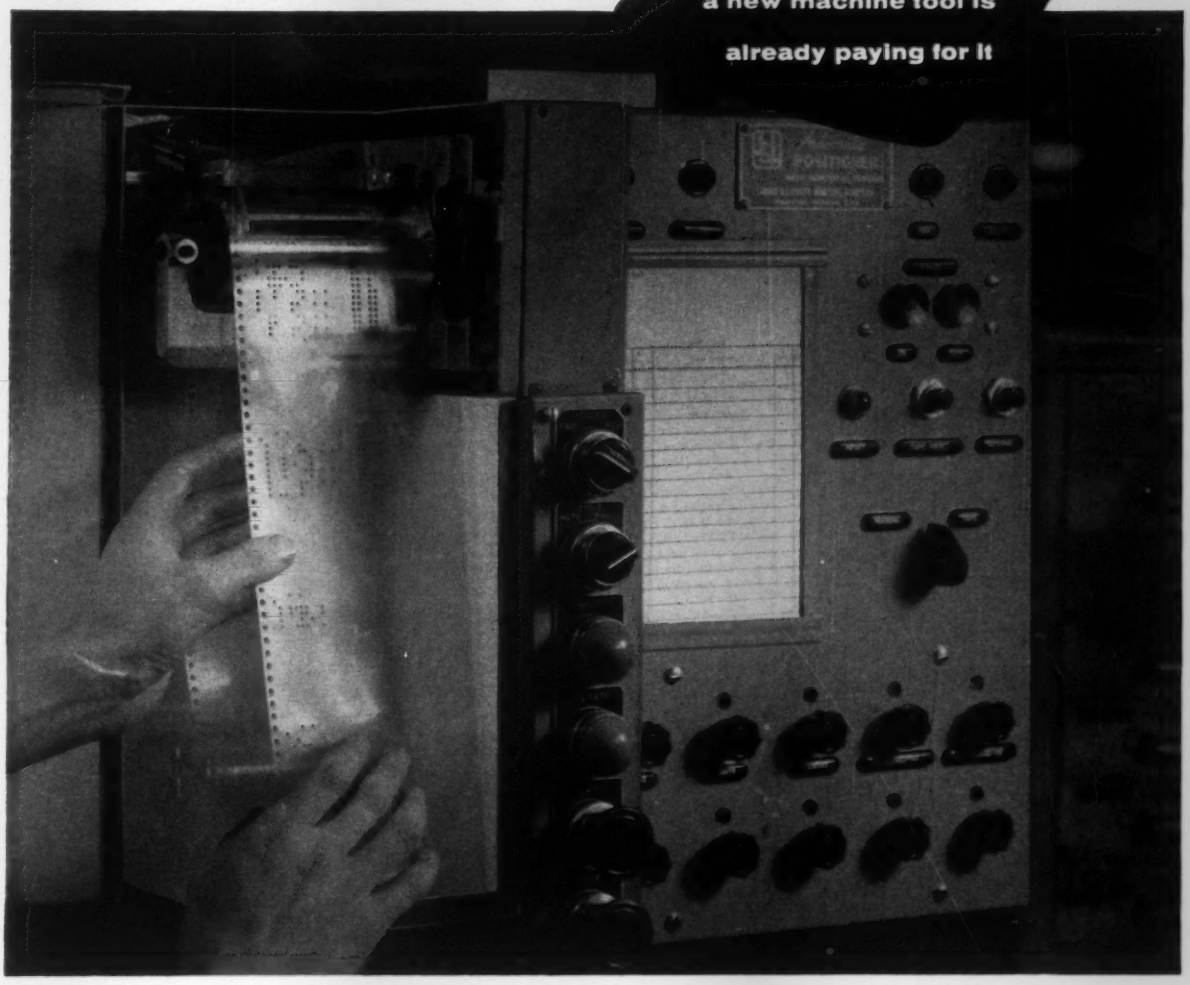
Second to be offered will be two-axis digital numerical control positioning systems. An all-numeric approach is employed to insure accuracy. Each 0.001 inch increment is given a discrete address so that errors of counting, differential positioning, or analog interpolation are eliminated. Versatility is provided by means of a number of compatible modules which may be assembled to obtain system characteristics of any desired complexity.

Cold Cathode Tube Features Quick Startup And Reliability

DEVELOPMENT of a new type electron tube which does not require a hot cathode to maintain electron emission has been announced by the Dept. of the Army. The new cold cathode electron tube was developed jointly by the U. S.

JONES & LAMSON "AUTOMATION"

the man who needs a new machine tool is already paying for it



Numerical Control . . . what's it worth?

What *about* numerical control: is it all it's cracked up to be? The answer, in a word, is "yes". Here's why. With numerical control, the *big* factor is *flexibility*. Tape or numerical programming can be employed economically for medium or small lot production, even down to *single pieces*. Accuracy is also increased. For instance, Jones and Lamson tape controlled positioning units hold tolerances of ±.001 on applications for punching, drilling, boring or similar operations where point-to-point positioning is mandatory. Machine set-up and change-over become primarily an office procedure. Numerical control of machining operations eliminates the need for cams, templates, even prototype parts and special fixtures. It results in greater machine utilization, and speeds actual machining. Lead time is reduced, and because human error is largely eliminated, accuracy is improved.

Any way you look at it, numerical control has come of age. It's being used more and more, simply because it produces better, at lower costs. For detailed information, write Jones & Lamson Machine Company, Dept. 710, 536 Clinton Street, Springfield, Vermont.

Turret Lathes • Automatic Lathes • Tape Controlled Machines • Thread & Form Grinders • Optical Comparators • Thread Tools

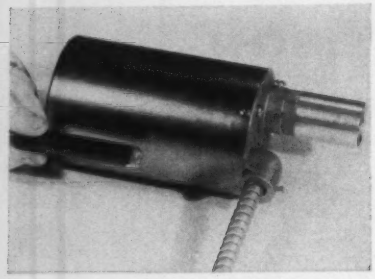
Circle 669 on Page 17

Army Signal Corps and Tung-Sol Electric Inc., and it could have as great an impact on electronics as the discovery of the transistor.

The cold cathode tube differs physically from a standard hot cathode tube in only two ways—one, magnesium oxide coats the cathode, and two, the tube contains a small tungsten starter filament. Once started by the tungsten filament, the tube continues to operate without heat being applied to the cathode. Instead of heat, a high voltage field causes electron flow which, in turn, produces the tube's characteristic phosphorescent blue glow.

Principal advantages of the cold cathode tube are quick starting, less cathode power required for operation, long life, and greater reliability due to elimination of heater burn-outs. Conventional hot cathode tubes normally require about 30 seconds before reaching operating temperature. The new tube starts electron emission in less than one second. Hot cathodes consume approximately 7½ watts of power per tube while the cold cathode uses only 0.75 watt per cathode. Plate power is the same for both tubes, and the two types are about equal with respect to cost, noise level, and other characteristics.

The cold cathode principle is believed adaptable to almost all types of electron tubes, including television, radar, and transmitting tubes, as well as nearly all general-purpose radio tubes. Miniature and subminiature tubes, which could equal the transistor in size, are also feasible.



FLAME detection device that can be used on all types of heating or processing burners has been developed by Minneapolis-Honeywell Regulator Co. Heart of the unit is a new ultraviolet-sensitive tube (shown being held) that works with an amplifier circuit to add up the impulses of electrical energy generated by the tube as it counts the ultraviolet rays present in all types of flame. The system can be used with all fuels, including gas-oil combinations, and on single and multiple burners. Unit responds only to ultraviolet light and is not affected by hot refractories, incandescent light, hot metal parts, or flickering radiation.

SPOTLIGHTING PEOPLE

Jerome T. Coe named general manager of the Silicone Products Dept., General Electric Co. . . . **George P. Walker** joined Ampex Corp. as senior staff engineer in the Instrumentation Div. . . . **Arthur H. Van Wormer** appointed sales manager, Industrial Products Dept., Machinery Hydraulics Div., Vickers Inc. . . . **James W. Lewis** joined Swanson-Erie Corp. as manager of sales engineering for special automatic processing and assembling machines. . . . **E. A. Holmes III** named product manager, Industrial Products, for Autonetics, Div., North American Aviation Inc. . . . **B. Von Mayrhauser** appointed general manager at Baird-Atomic Inc. . . . **Jacob J. Jaeger** appointed executive vice president and **Edward J. Shages** named vice president in charge of manufacturing for all operations at Pratt & Whitney Co. Inc. . . . **Wesley E. Niemond** appointed head of the Tape Center Dept., at Electronic Control Systems, Stromberg-Carlson. . . . **Harold A. Johnson** elected vice president in charge of engineering and manufacturing at Barnes Drill Co. . . . **Robert C. Doss** appointed division sales manager of Lincoln Engineering Co. . . . **Duane R. Branaka** named general sales manager of Sinclair-Collins Valve Co. and Valvair Corp.

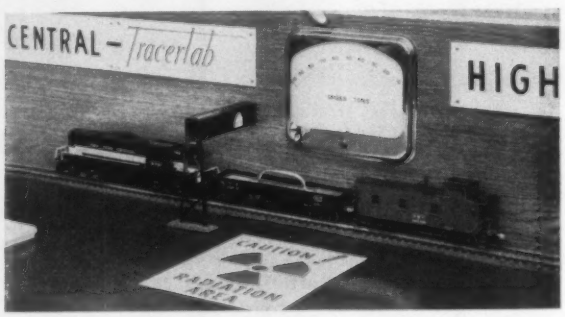
Nuclear Scale Weighs Rolling Freight Cars

FREIGHT CARS moving as fast as 30 miles per hour can be weighed by a nuclear scale developed by the New York Central Railroad with assistance from Tracerlab Inc. An operating model of the scale, complete with train, track, and gamma ray source, is shown in the accompanying photograph and will be displayed at the International Trade Fair in Tokyo, Japan, during May.

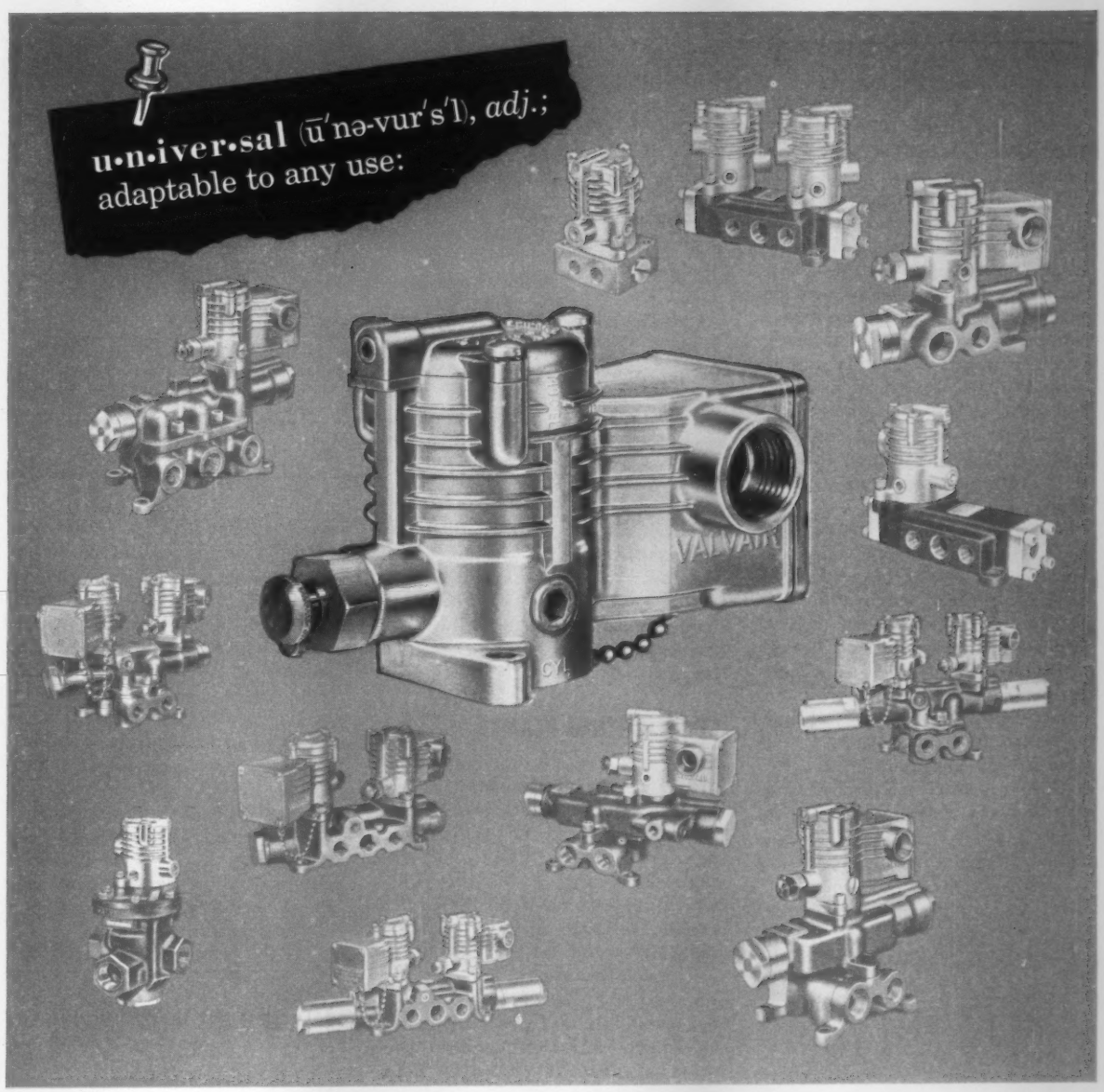
In the scale model shown, gamma rays are emitted from a Cesium 137 source located under the tracks. Directly above, a scanning bridge counts the gamma rays as they penetrate each miniature freight car. Each car absorbs a certain amount of rays according to the density of its contents. The information obtained by the counter is translated into weight and shown on the meter which is graduated in tons for the model display.

The full-sized scale for railroad yards works in a similar manner as the model scale. However, instead of recording the weight on a meter, the large scale uses a scintillation counter to record the gamma ray absorption and feeds this information to a computer which calculates the weight of the car and records the answer on a graph. Cobalt 60, a more active radioactive isotope source, is used in the actual scale in place of Cesium 137.

James J. Wright, director of the New York Central Technical Research Center, said that the nuclear scale will increase the weighing speed of freight cars and would eliminate the necessity of uncoupling the cars as is now required. Mr. Wright explained, "In addition, these atomic scales will be far cheaper. We estimate that they won't cost us more than $25,000 each. We pay $110,000 for the instrumented scales."



Although the scale will be shielded automatically when not in use, it will pose no radiation threat to railroad workers or shipments. The radioactive rays emitted by the source will not be enough to damage a shipment as sensitive as photographic film. The Central will build and install a full-sized field unit of the weighing system during the next year.



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Other INDUSTRIAL DIVISIONS of IBEC: The Sinclair-Collins Valve Co. The Bellows Co., Akron, Ohio • V. D. Anderson Co., Cleveland, Ohio.

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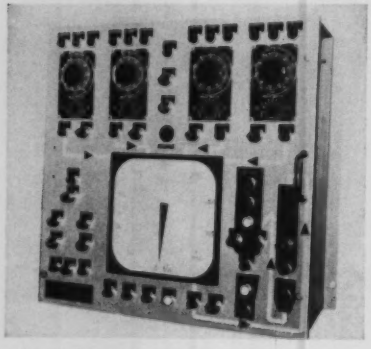
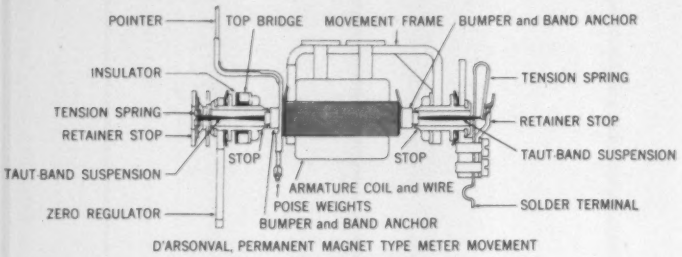
. . . **Fred Wohlman** joined Continental Device Corp. as manager of mechanical engineering. . . . **Dr. Mervin J. Kelly**, retiring chairman and former president of Bell Telephone Laboratories, engaged by International Business Machines Corp. as a consultant on research and engineering. . . . **George Loomis** named manager of the Receiving Tube Div., Raytheon Mfg. Co. . . . **Walter R. Kuzmin** joined Technical Products Div., Packard-Bell Electronics Corp., as manager of reliability engineering. . . . **C. W. Trautman** appointed manufacturing manager of the George L. Nankervis Co. . . . **U. Victor Turner** named manager of manufacturing for Data-Control Systems Inc. He will be responsible for manufacturing engineering, assembly, and production control within the company. . . . **George P. Fryling II** appointed vice president of manufacturing at Erie Resistor Corp. . . . **Langdon C. Schaefer** joined Century Electric Co. as manager of engineering. . . . **Rex B. Grey** appointed manager of Control Div., Southwestern Industrial Electronics Co. . . . **K. D. Garnjost** named chief engineer of Moog Valve Co. Inc. . . . **H. R. Alexander** appointed director of field engineering, Whittaker Controls Div., Telecomputing Corp. . . . **T. M. Fitzgerald** named general manager of the Electronics Div., P. R. Mallory & Co. Inc.



CONTROL SYSTEM developed by Richardson Scale Co. accurately weighs up to four ingredients used in making a coffee blend. Weight selector verniers control separate material feeders which deliver different grades of coffee sequentially to a weigh hopper. Up to 500 pounds of each ingredient is weighed individually by the hopper, and then discharged to a common mixer. After four weighments have been delivered to the mixer, the scales shut down while the mixer operates for a pre-set time and then discharges to a holding hopper. The weighing process then automatically repeats until all ingredients have been blended.



D'ARSONVAL, PERMANENT MAGNET TYPE METER MOVEMENT

TAUT BAND meter suspension developed by Hickok Electrical Instrument Co. completely eliminates conventionally used pivots, jewels, and hairsprings for movement support and provides a friction free meter movement with sensitivities on the order of ½ microampere for 100 angular degrees pointer deflection. Instead of the conventional means of support, the new meter movement uses thin metal bands to support the movement, carry current, and provide restoring torque. The meters have an overload capacity of up to 5 times full scale current for an indefinite time and are unharmed by surges up to 300 times normal current.

SPOTLIGHTING PLANTS

Koehring Co. has acquired the complete business of **Cast-Master Inc.**, manufacturer of diecasting machines. The new acquisition will be operated as a division of Koehring's Hydraulic Press Mfg. Div. which manufactures hydraulic presses, plastic injection molding machines, and dieing machines. . . . **Topp Industries Inc.** has announced the formation of **U. S. Science Corp.** as a wholly-owned subsidiary which will acquire operations of Topp Mfg. Co. All Topp Mfg. Co. aviation programs will be undertaken by the new corporation, and communications, navigation, and component business will be subcontracted by Topp Industries to the subsidiary. . . . **Photomation Inc.** is the new name for the former **ESS Instrument Co.** . . . **Servomechanisms Inc.** and **Laboratory for Electronics Inc.** have announced jointly that their respective companies are investigating plans for a merger. No date has been set for submission of a merger plan to the stockholders of each corporation. . . . **General Ceramics Corp.** has announced the formation of an Applied Logics Div., an autonomous unit, to design, manufacture, and market improved buffer memory systems for special computer applications. . . . **Electronic Control Systems** facility of **Stromberg-Carlson** has formally opened the first automatic data processing center on the West Coast for the preparation of magnetic tapes to be used to operate numerically controlled machine tools. Located in Los Angeles, the facility will function as a customer service organization to prepare tapes to customers specifications for the operation of ECS contouring control systems. . . . **International Resistance Co.** has reorganized its wholly-owned subsidiary, **Circuit Instruments Inc.**, and will operate it as the Circuit Instruments Div. of IRC.

MEETINGS AND EVENTS

April 6-10—

American Welding Society. 40th Annual Convention to be held at Hotel Sherman, Chicago, and the Welding Show to be held April 7-9 at the International Amphitheatre, Chicago. Additional information is available from AWS headquarters, 33 W. 39th St., New York 18, N. Y.

April 7-10—

Numerical Control in Industry. Joint conference presented by Purdue University and University of California. Western phase occurred earlier on March 22-25 at University of California Conference Center, Lake Arrowhead, Calif.; and Eastern conference to be held April 7-10 at Memorial Center, Purdue Campus. Further informa-

Circle 671 on Page 17→

GAYLORD PACKAGING
GIVES PRODUCTS SAFE-CONDUCT

Nothing like a feeling of security when products get their travel orders, what? Gaylord corrugated boxes give safe-conduct. Strong, stout, sound, snug. Special materials, adhesives. Most ingenious chaps, Gaylord packaging engineers.

Should you require regular containers in vast quantities, or specialized packaging, your nearby G-Man is jolly well ready to discuss economical protection. You, too?

GAYLORD
CONTAINER CORPORATION

Gaylord Boxes

HEADQUARTERS, ST. LOUIS
PLANTS COAST TO COAST

DIVISION OF **Crown Zellerbach Corporation**

NEW WESTINGHOUSE LIMITEMP
Indicating Temperature Control

Limitemp* is a new, medium-priced control device that is ideal for monitoring or controlling temperatures between 100° F and 400° F. Controller may be used to indicate temperature and sound an alarm if temperature exceeds the preset point. A few applications include windings of large rotating machines, bearings, process temperatures and controlling temperatures in critical areas such as nuclear controls.

Limitemp employs magnetic and semiconductor elements of proven reliability; therefore, no vacuum tubes, no moving parts, no contacts . . . nothing to wear out.

LIMITEMP CHARACTERISTICS:

INPUT: 115 volts, 60 cycles OUTPUT: 24 volts d-c at 5 watts
TEMPERATURE RANGE: 100° F to 400° F—40° C to 200° C
INDICATION: Dual-scale calibrated meter and pilot light
ACCURACY: Setting ±1%, indicating ±2%, bandwidth 2% of range
COMPACT: 4 in. wide, 8½ in. high, 6 in. deep

GET ALL THE FACTS . . . write Westinghouse Electric Corporation, Director Systems Dept., 356 Collins Avenue, Pittsburgh 6, Pa. Complete information on the new Westinghouse Limitemp will be sent to you by return mail. J-01008

*Trade-Mark

YOU CAN BE SURE . . . IF IT'S Westinghouse

WATCH "WESTINGHOUSE LUCILLE BALL-DESI ARNAZ SHOWS" CBS TV MONDAYS

tion may be obtained from Div. of Adult Education, Purdue University, Lafayette, Ind.

April 13-15—

American Society of Mechanical Engineers. Hydraulic Div. Conference to be held at University of Michigan, Ann Arbor, Mich. Additional information is available from ASME headquarters, Meetings Dept., 29 W. 39th St., New York 18, N. Y.

April 13-15—

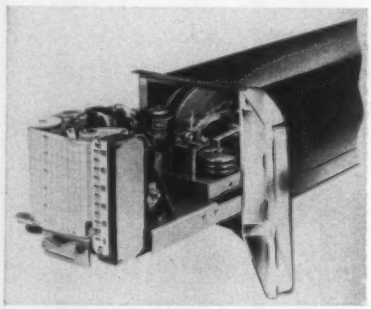
Life Office Management Association. Automation Forum for users of magnetic tape data processing equipment to be held at the Drake Hotel, Chicago. Further information can be obtained from LOMA headquarters, 110 E. 42nd St., New York 17, N. Y.

April 13-17—

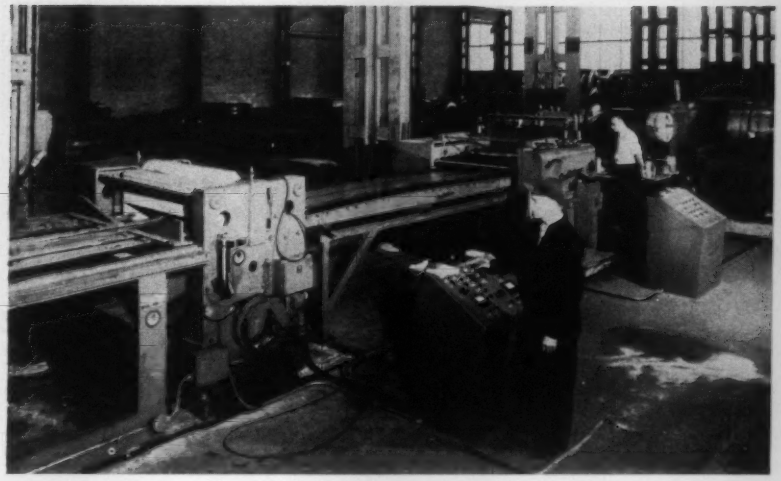
American Management Association. 28th National Packaging Exposition to be held at the International Amphitheatre, Chicago. Additional information is available from AMA headquarters, 1515 Broadway, New York 36, N. Y.

April 14-15—

Armour Research Foundation. Conference on Industrial Instrumentation and Control to be held at Illinois Institute of Technology, Chicago. For further information, contact M. J. Jans, Conference Secretary, Armour Research Foundation, 10 W. 35th St., Chicago 16, Ill.



PNEUMATIC transmitting models are now available in the Series 663 Dynamaster instruments manufactured by the Bristol Co. While retaining all the features of Dynamaster electronic instruments, the pneumatic transmitting models are especially suitable for use with Bristol's Metagraphic pneumatic instruments. Model 663 is easily adapted to ratio, cascade, and computer-type control systems, and offers the plugin convenience of the pneumatic line of instruments.



SHEET STEEL shear line, installed in the Steel Warehouse Div., R. C. Mahon Co., is designed to handle galvanized stock in widths up to 48 inches and at rates of 35 to 210 feet per minute. Built by Dahlstrom Machine Works, the shear line can be preset to cut lengths of stock needed, number the pieces, and cut and stop automatically. In operation, the steel is unrolled from coils, straightened, cut to length with an accuracy within 1/32 inch, and then roller leveled again. The line will process metal thicknesses varying from 20 gage to 3/16 inch.

April 21-23—

American Society of Lubrication Engineers. Annual Meeting to be held at the Statler-Hilton Hotel, Buffalo, N. Y. Additional information is available from ASLE headquarters, 84 E. Randolph St., Chicago 1, Ill.

May 11-13—

Instrument Society of America. Second Annual Power Conference to be held at the President Hotel, Kansas City, Mo. Additional information is available from Charles Koegel, Westinghouse Electric Corp., 8900 Westbrook Drive, Overland Park, Kans.

May 11-13—

Second Annual Joint Conference on Automatic Techniques. Sponsored jointly by the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the Institute of Radio Engineers, meeting will be held at the Pike Congress Hotel, Chicago. For further information, contact F. D. Snyder, Westinghouse Electric Corp., 40 Wall St., New York 5, N. Y.

May 12-14—

American Society of Mechanical Engineers. Production Engineering Div. Conference to be held at the Statler-Hilton Hotel, Detroit. Additional information is available from ASME headquarters, 29 W. 39th St., New York 18, N. Y.

May 25-27—

American Society for Quality Control. Annual Convention and All Industry Production & Quality Control Exposition to be held at Public Hall, Cleveland. Additional information is available from ASQC headquarters, 161 W. Wisconsin Ave., Milwaukee 3, Wis.

May 25-28—

American Society of Mechanical Engineers. Design Engineering Show and Conference to be held at Convention Hall, Philadelphia. Further information is available from Clapp & Poliak Inc., 341 Madison Ave., New York 17, N. Y.

"There's your bottleneck in the Gillins order!"

Another RCA AUTOMATION Product for Better Materials Handling

Low cost automatic

RCA ROTARY HOPPER

Compare the cost and features of these new RCA Automatic Rotary Hoppers, and you'll see why they are gaining such rapid acceptance! They provide every needed operating feature, yet are offered at remarkably low prices . . . beginning at $265, f.o.b., Detroit.

Features:

- **High-speed—up to 20,000 parts per hour.**
- **Handles cylindrical, rectangular, headed disc shaped and other parts.**
- **Parts orientation performed by feed track, not the bowl.**
- **Feed tracks easily changed by loosening one screw.**
- **18", 24", 30" bowls available.**
- **Rugged construction—cast-iron frame; driving mechanism supported by heavy duty self-aligning bearings.**
- **Standard gear-head motor.**
- **Safety-slip drive protects parts and equipment.**
- **Price includes cleats on selector ring and mounting block for tracks.**
- **Demand-control mechanism and wide variety of discharge tracks furnished at modest extra cost.**

Write today for complete information on low-cost RCA Rotary Hoppers. To permit analysis of your needs, send two samples of each part to be handled, and indicate required production rates. Details of other RCA Automation Equipment available on request.

RCA Tmk(s)®

RADIO CORPORATION of AMERICA

INDUSTRIAL AND AUTOMATION DIVISION
12605 Arnold Ave., Detroit 39, Mich.

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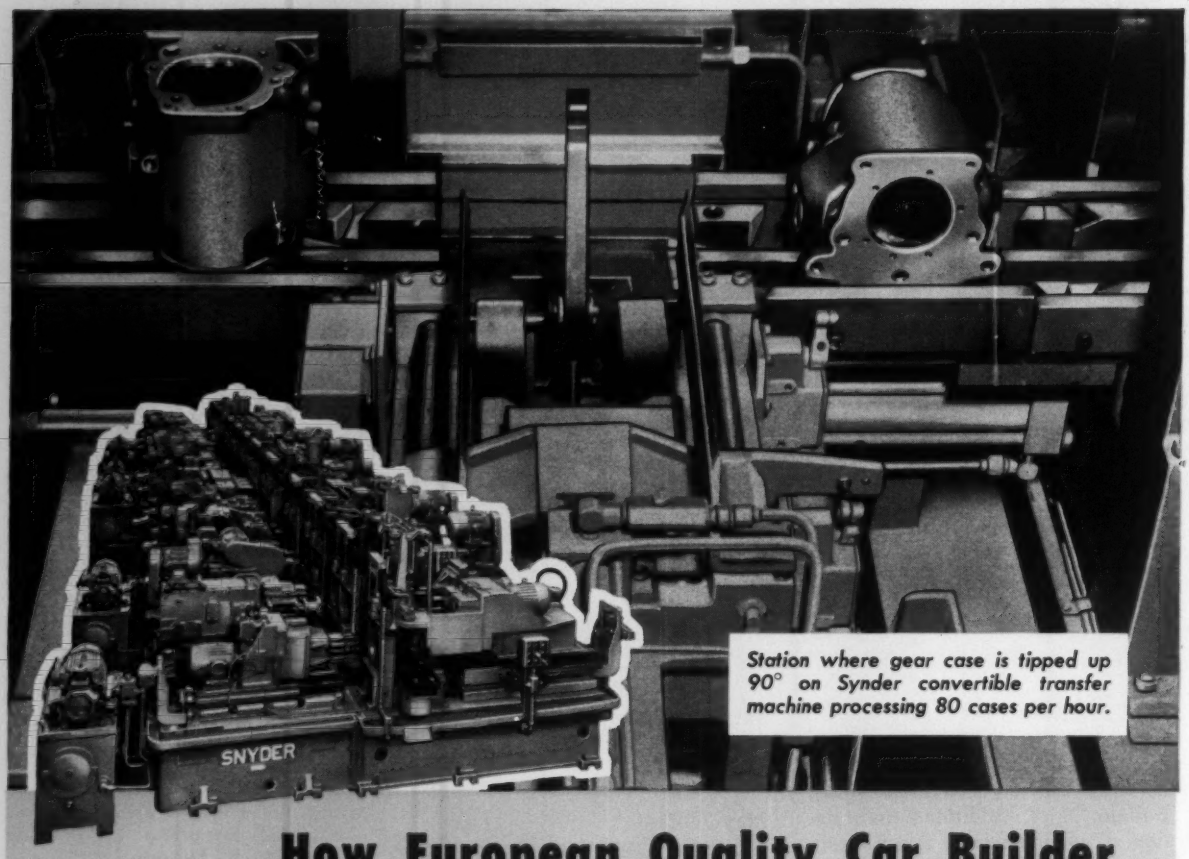

Station where gear case is tipped up 90° on Synder convertible transfer machine processing 80 cases per hour.

How European Quality Car Builder Snyderizes for the Soaring Sixties

This new 53-station transfer machine combines special purpose efficiency with high convertibility for later changes. Part orienting devices enable Snyder to utilize standard horizontal way-type units to drill, spotface, chamfer, ream, line-ream, mill and bore this cast iron standard gear transmission case on all faces. The cases are turned 90° at the thirteenth station and tipped up 90° at the thirty-eighth station, which eliminates vertical machining units. The part is specifically located on faces not subject to future design changes, thus reducing future capital expenditure.

* * *

Let us show *you* how to SNYDERIZE FOR THE SOARING SIXTIES for more efficient parts handling, gaging, assembly and machining. Send or phone for new brochure with resume of Snyder machines engineered for profit improvement.

Standard Features of Snyder Machines

1. SNYDER SELF-CONTAINED UNITS and other units equipped with hardened and ground steel ways.
2. Threading and tap heads equipped with individual lead-screw spindles.
3. Minimum downtime for tool changes because spindles are arranged for pre-set cutting tools.
4. Automatic lubrication.
5. J.I.C. Standards throughout.
6. Electrical interlocks and full depth circuit throughout.
7. Panels equipped with SNYDER CIRCUIT SLEUTH.

SNYDER CORPORATION

(Formerly Snyder Tool & Engineering Company)

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Circle 674 on Page 17

By JAMES C. KEEBLER Managing Editor

One of the largest aluminum parts now being used in the automotive industry is the automatic transmission casing produced by Ford Motor Co. at its Sheffield, Ala., plant. The 24-pound, bellshaped cases are cast in three-sided permanent molds. Redesigning and use of the light metal casing enabled Ford engineers to reduce the weight of the 1959 Ford automatic transmission by about 50 pounds.

Materially Different

COMPANIES interested in selling to automaters are usually classified into one of two categories: 1. Designers and/or builders of automated production equipment. 2. Suppliers of component parts of automated production equipment. Recent activity would indicate that this simple *either/or* grouping is too restrictive. There's another group of merchants with wares to peddle who are knocking at the automaters doors.

Materials Suppliers

This third group has an interesting pitch and it looks like they can make it stick. Those companies who offer a material that is easy to fabricate automatically have a real message for the manufacturing engineers who devise the automated production processes: "If your product is made of, from, or with our material you can gain added cost savings in manufacture." Recognizing that the cost of production plays a big part in automotive product specifications the vendor wisely sees that if the manufacturing engineer knows about his material and the associated processes he will certainly influence the product designers thinking with regard to such specifications.

There are many cases in point. If a rivet manufacturer can provide automatic riveting equipment he can sell more rivets. If an adhesives supplier can show you how to automatically apply the goo, he can sell more of it. Manufacturers of vinyl coated sheet steel look longingly at the number of applied linoleum panels going into station wagon interiors and recognize that automated fabricating techniques are the key to tapping a big market. The list of potentials is long.

Versatile Aluminum

One of the materials on the list is aluminum. The Aluminum Co. of America has co-sponsored demonstrations with builders of automatic screw machines to show how the multiple spindle jobs can really spit out aluminum parts. The message is getting through. This is a versatile material.

Ford's C. H. Patterson, vice president of the power train group, is quoted: "We have found that aluminum can be subjected to as wide a range of processes as any other metal we use. It can be rolled, stamped, extruded, cast, drawn, machined, welded, and colored. Such versatility, combined with reasonable cost, will assure a healthy future for aluminum in the automotive industry."

Roll forming, stamping, diecasting, and extruding are all processes of particular interest to automaters because they can produce varied shapes relatively automatically and leave very little machining to be done on subsequent operations.

The present is the future of the past and it reveals a big growth curve of acceptance of aluminum as a material for auto parts. Industry reports indicate that the 1955 average was 30 pounds per car. The average for 1959 is expected to be either 51.58 or 57 pounds, depending upon which of the aluminum industry sources is being quoted. Patterson predicts that within five years the average passenger car will contain from 100 to 120 pounds of aluminum. Already a Lincoln Premiere has 84 and a Chrysler Imperial Convertible tips the scales with a winning 121.24 pounds.

Alcoa figures that if an aluminum engine were placed in the average U. S. car today, that car would utilize about 180 pounds of aluminum. In a 5.5 million car year they say this would require more than one billion pounds of aluminum—

32 per cent of U. S. primary aluminum production in 1958.

Though aluminum blocks can be bought as standard in outboard motors, they're still not available from the local authorized auto dealers. But this doesn't mean there aren't a lot of people working on it. Recognizing the possibility of more light metals in engines and cooling systems Leonard C. Rowe of General Motors Research Labs. Chemistry Dept. told the Chemical Specialties Manufacturers Association that they should be prepared to provide materials which are effective in a light metal cooling system, or alternative methods of cooling must be found. Rowe says: "Regardless of how extensively aluminum is used, it will result in corrosion problems which are slightly different in nature than those previously experienced. Pitting and galvanic corrosion are sure to be more prominent."

Some Like It Hot

Ford has an aluminum casting plant in the South and they get their aluminum from Reynolds Metals Co. in the *molten* state. One of the few automotive facilities exclusively devoted to the production of aluminum parts, the plant is five miles from Sheffield, Ala., and a quarter mile from Reynolds' Listerhill reduction plant.

Molten aluminum, alloyed to Ford specs with silicon, copper, and manganese, is transported on flatbed trucks over a connecting private road. Ten truck loads, each consisting of two 5000 pound ladles of aluminum, are delivered during each 24 hour period, seven days a week.

During the trip the metal temperature drops only about 100 degrees to a receiving temperature of 1400F.

By overhead crane and mechanized pouring spout, the aluminum is transferred into one of eight 65,000-pound holding furnaces. These are also capable of melting pig aluminum, if required. In addition, the plant has six 20,000-pound furnaces for remelting metal trimmed from production pieces, as well as for holding metal before it is released to forming machines.

As production requirements demand, material in the larger furnaces is further alloyed with magnesium or iron. Then it is refined by gaseous chlorine and transferred to 2000-pound ladles, which travel by overhead monorail to the casting areas.

Metal is held at each casting operation in furnaces which have a capacity of approximately twice that of a bathtub. Then the aluminum is either hand-ladled (poured into molds) or squirted (forced by hydraulic pressure) into machines which can be changed to form the various 67 automobile parts made in this plant.

After removal from forming machines, parts are trimmed, heat cured, rough machined, weight checked, and packed for shipping.

Operators at each of the 83 die casting and permanent molding machines in this plant have their own supply of fresh air, which is brought to the operator's area by an underground network of piping.

Each man can control the amount of fresh air he desires on the job. During winter weather, this air is conditioned so that machine operators receive it at a comfortable temperature.

Parts range from 0.053 pound to 24 pounds. The smaller casting is a throttle control piece which closely resembles a polychoke as used on a shotgun. The 24-pound automatic transmisison housing, largest aluminum part in Ford cars, is later machined to an approximate weight of 22½ pounds.

Pistons are produced in nine different sizes and at the capacity rate of 50,000 per day. Individually weighed and inspected before shipment is permitted, pistons must be within a 15-gram weight spread before okayed.

Weights of the nine different pistons range from 655 grams to 1017 grams. Even though precision machining is yet to be done, the permitted tolerance for a piston, on leaving the plant, is about the weight of a half-dollar.

Long Sell

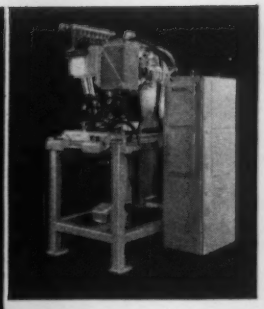
The idea of buying the aluminum in the molten state and avoiding the cost of remelting pigs reveals some integrated thinking concerning the over-all processes of manufacture. David Reynolds, executive vice president of Reynolds Metals says they are proud to have initiated long-term contracts guaranteeing that the auto industry's long-range planning and billion dollar decisions would not be frustrated by an unstable source of supply.

The aluminum salesman has a big foot in the automaters door and other material manufacturers are following suit.

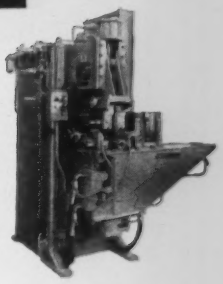
Two 5000 pound capacity crucibles of molten aluminum are loaded on a Ford Motor Co. truck in the Reynolds Metals Co. Listerhill reduction plant. The molten metal is carried to the nearby Sheffield plant of Ford where it is cast into a variety of automotive parts.

automatic national electric welders

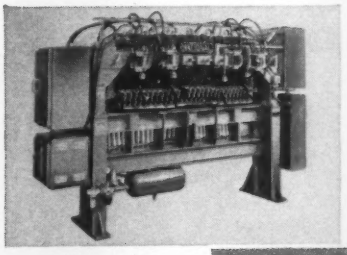
that are giving **big** production



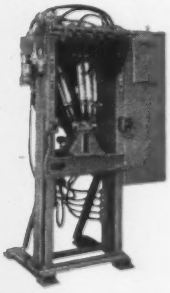
This six gun National Multi-spot Welder spot welds automobile ash tray assemblies at the rate of 650 assemblies per hour. (1 operator).



Feeding, forming, mash-seam welding and ejecting of small motor frames is done at the rate of 425 per hour on this National welder. (No operator).

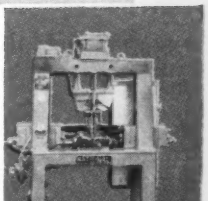


One man operates this 28-gun, air-operated unit that spot welds 300 radiator grille reinforcement assemblies per hour.

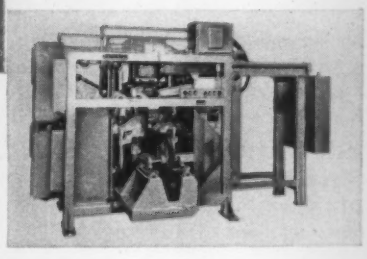


One of three identical National Electric machines for locating and spot welding 300 left-hand and right-hand automobile head-light assemblies per hour (on each machine).

A great variety of individually automated, high-production welding jobs throughout industry are being performed with amazing rapidity by National Electric Welding Machines . . . engineered and built for the job by National Electric. If you have a volume welding operation, an automatic National Electric unit specially designed and built for you can do the job faster and more economically. Here are a few typical examples . . .



This multi-spot unit spot welds 400 wire brush assemblies per hour. Fast change-over from one size to another. (1 operator).



Traveling fixtures locate and carry automobile engine supports past air operated guns at the rate of 600 assemblies per hour on this National unit. 20 welds per assembly. (1 operator).

NATIONAL

Electric welding machines co.

1870 N. TRUMBULL STREET

BAY CITY, MICHIGAN

25 YEARS' EXPERIENCE DESIGNING AND BUILDING: SPECIAL & STANDARD • AIR • HYDRAULIC • MOTOR DRIVEN • SPOT • PROJECTION • SEAM • BUTT • FLASH • RESISTANCE WELDERS • PRODUCTION FIXTURES FOR ALL TYPES OF AUTOMATIC ARC WELDING.

57

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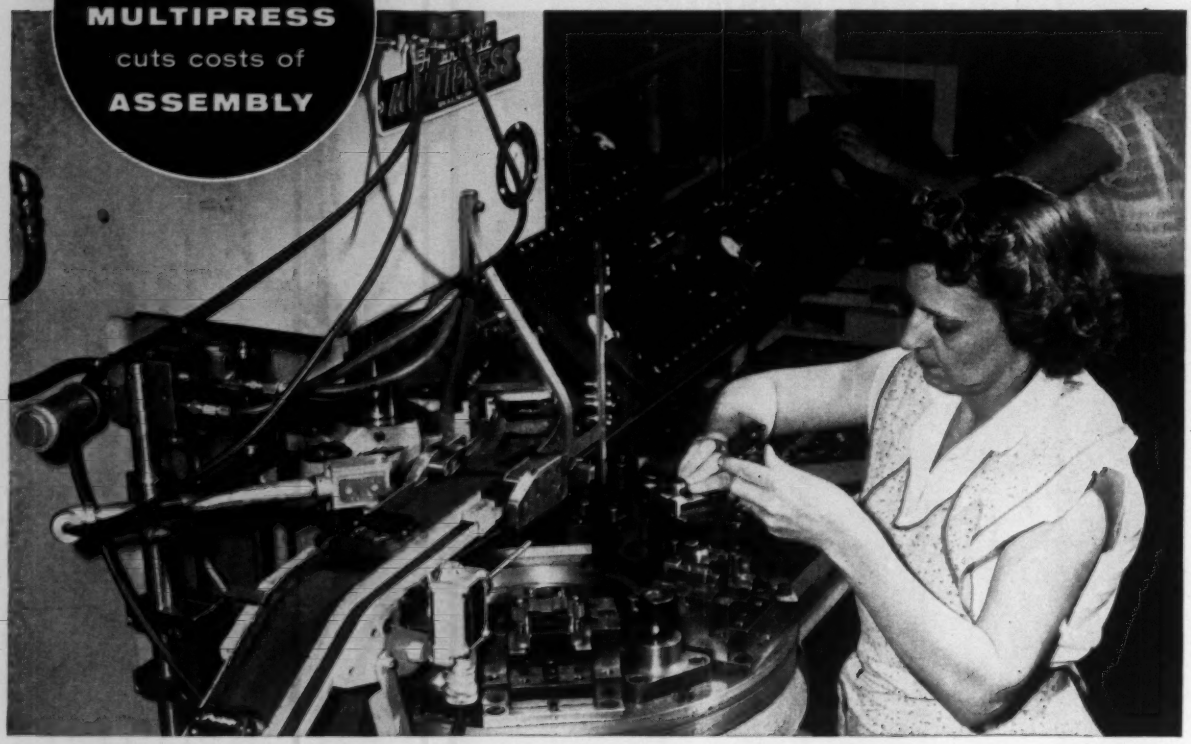
How **DENISON MULTIPRESS** cuts costs of **ASSEMBLY**

ONE OF THREE, *this Denison 4-ton hydraulic Multipress is equipped with 6-station automatic index table to assemble both halves of lamination stacks of small electric motors.*



Savings with **DENISON** Multipress justify MAPI replacement recommendations at **BARBER-COLMAN**

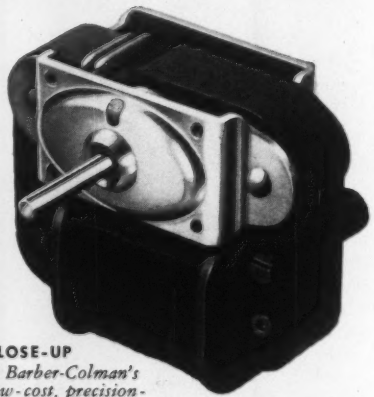
. . . line of 3 new hydraulic presses simplifies and speeds small motor assemblies

Installed upon recommendation of a MAPI replacement analysis, three Denison hydraulic Multipresses are today meeting predicted cost reductions in assembly operations at Barber-Colman Company, Rockford, Illinois.

Operating in a line and connected by conveyor belts, these three hydraulic presses handle—on a semi-automatic basis—such operations as bending, staking, aligning, compressing, riveting and stamping in the production and assembly of small electric motors.

In addition to more efficient handling of production functions, the quality of output is more uniform because exact pressure is duplicated on each stroke of the hydraulic ram.

Savings in cost and uniform production like this can be duplicated in your shop today. A cost reduction study by a Denison Specialist in press work can show you how. Write today for a descriptive catalog on the complete Multipress line.



CLOSE-UP
of Barber-Colman's low-cost, precision-made, AC non-geared motor . . . assembled by Denison Multipresses.

HYDRAULIC PRESSES • PUMPS • MOTORS • CONTROLS

DENISON HydrOILics

DENISON ENGINEERING DIVISION
American Brake Shoe Co.
1234 Dublin Road • Columbus 16, Ohio

Denison Stocking Branch Offices: LOS ANGELES • HOUSTON
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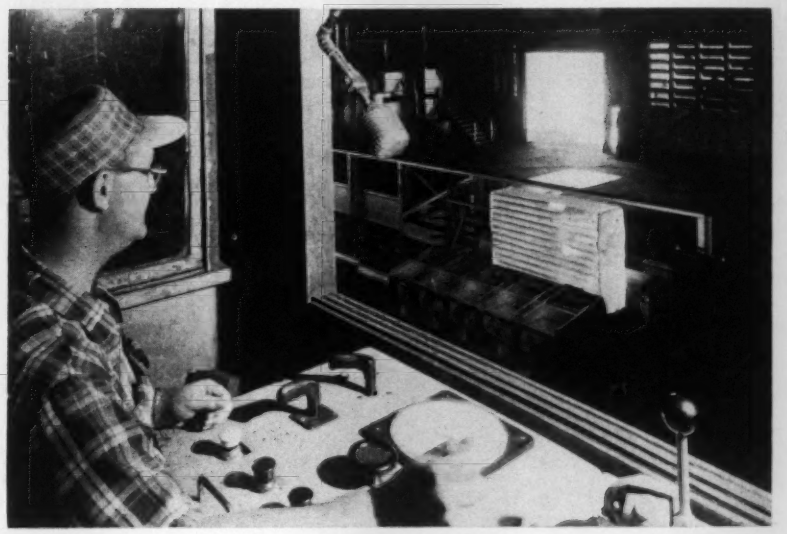
Circle 676 on Page 17

western trends

By PATT PATTERSON
Los Angeles, Calif.



Automatically-positioned ingot buggy attached to a cable running between two large drums replaces a self-propelled buggy in a plant of Columbia-Geneva Steel Div., U. S. Steel Corp. General Electric control system enables operator to precisely control movement of buggy by pushbutton control of the winding and unwinding of the cable on the two drums.

From Receiving To Shipping

ALTHOUGH a great deal of the attention focused upon automation has been directed to fabrication and assembly, materials handling functions are a major factor in planning for new facilities and in modernizing older plants. The big consideration in the past has been to automate individual pieces of equipment and to manually transfer raw materials, parts, and supplies between these automatic machines. Production planners, however, are now taking another look at the whole picture, and this includes the flow of materials from receiving to shipping. In many cases, savings of time which have been effected by the use of numerical control have been nullified by slowups in getting the parts to and from the machines.

Some effort has been made in developing automatic series equipment. On such a "line" of machines, the automatic transfer mechanism is engineered as a function of the machines. But there are a number of sequences where this type of approach is not practical as a solution to automatic handling. Where limited use of in-line equipment is made, supplemented by manual loading and unloading, savings have still been clear cut enough to justify major equipment and control purchases.

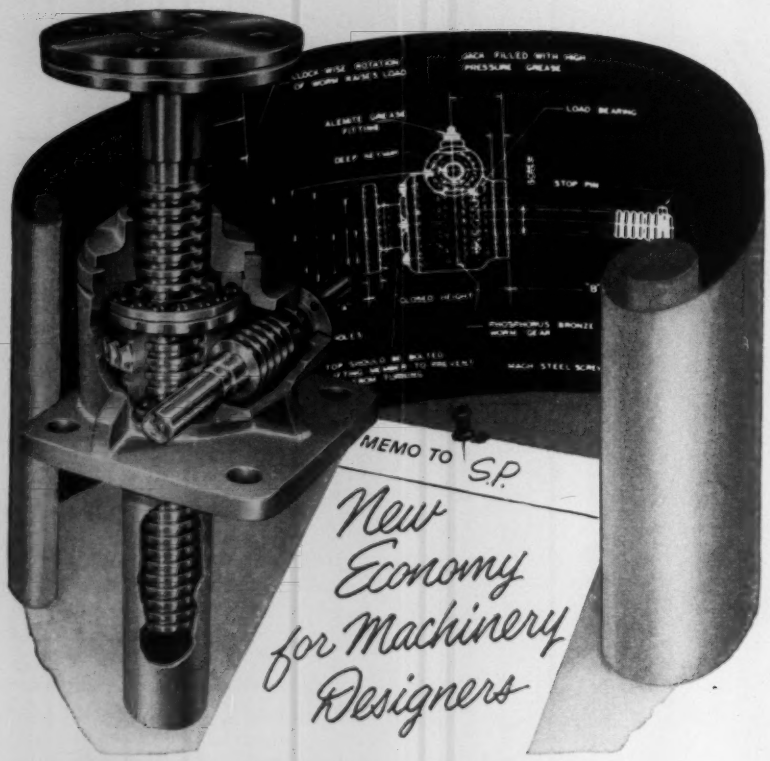
In San Diego, at the Convair Div. of General Dynamics Corp., parts for the F-102A supersonic jet interceptor are fabricated on automatic equipment. A three-stage semiautomatic drill station, for example, cuts rejects by 75 per cent and saves almost two hours on every part produced. Separate heads do rough drilling, reaming, and tapping operations. The parts are moved from one machining position to the next by a hydraulic ram, which automatically positions the part in exact relationship to the drill heads. Precise indexing by the automatic ram has reduced rejects to a minimum.

Another piece of equipment in Convair's F-102A plant uses a large, 60-inch indexing table in order to insure precise and rapid transfer of parts. Seven holding fixtures secure up to six different parts around the edge of the table. There are eight drilling and tapping stations, involving 16 units. The drilling and tapping is done at a 30-degree angle. The table, operated by a single man at a control panel, swings the part into place in 4 seconds. The machining takes less than one minute. An automatic device prevents the drilling and tapping units from operating if a station is empty.

In some situations, manual control of materials handling is considered to be an essential ingredient of proper operation. Here, automatic equipment is functioning as an extension of the operator's own limbs—permitting him to handle objects faster, easier, and more precisely than he could manually.

The California Packing Co. uses such a system in their Sacramento plant. Here an operator uses a semiautomatic pallet loader to stack cartons of various sizes and shapes on loading pallets. The equipment is very similar to automatic pallet loading mechanisms; however, the automatic pattern forming mechanism has been removed so that the operator forms the patterns himself. This permits rapid switching from size to size and eliminates the necessity for downtime to readjust the equipment for different sizes and shapes.

Various pallet types and sizes are



NOW, A STANDARD LINE OF DUFF-NORTON WORM GEAR JACKS

The economies of standardized production now can be realized by machinery designers who use Duff-Norton worm gear jacks for accurate positioning of loads weighing as much as several hundred tons. After 25 years of experience and hundreds of custom designs, Duff-Norton engineers have produced a standard line of eight jacks ranging from 2 to 100 tons in capacity which will meet almost any requirements. When jacks are used in an arrangement, added economy can be realized in raising unevenly distributed loads, since all models now have a uniform raise which permits jacks of varying capacities to operate in unison.

Worm gear jacks are purely mechanical devices, and they can hold heavy loads in position indefinitely without any creep. Functioning as components of machinery or equipment, they can raise or lower loads, apply pressure or resist impact. Worm gear jacks can be furnished with raises up to 24 inches, and they will provide exactly the same raise for years without adjustment.

Thousands of these jacks are in use on feeding tables, tube mills, welding positioners, pipe cut-off and threading machines, testing equipment, aircraft jigs, loading platforms, rolling mills, conveyor lines, and numerous other types of equipment. If you have a positioning problem, write for complete information, requesting Bulletin AD-66-GG, which includes drawings and full specifications.

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able to be mixed in the loading operation, and handling speeds have been approximately the same as for automatic units, depending upon the operator's ability to form the pattern necessary for the particular size container being stacked.

Wheeled Carriers

At Nalley's, Inc., a Tacoma, Wash., food processor and distributor, the problems of storage and materials handling in a warehousing operation dictated the use of a flexible system which would not involve fixed conveyors or other permanently installed systems. The final solution was an automatic tractor-train, which runs through the warehouse, following the aisles between receiving and shipping.

The Guide-O-Matic tractor is operatorless. It follows a 700-foot guide wire looped through the building from the receiving platform to the transient storage and order make-up area. After unloading, the tractor returns to the receiving dock for another load of food-laden trailers. There are only two automatic stops on the route at the present, but others could be added, and the route changed to encompass the entire plant area, if operations demand.

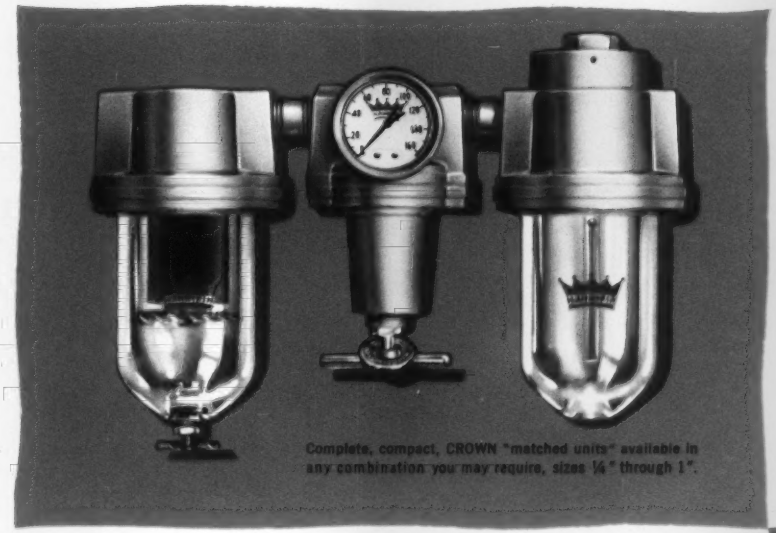
A more conventional transfer system is the automatically positioned ingot cart in the Geneva Works of the Columbia-Geneva Steel Div., U. S. Steel Corp., in Provo, Utah. The cart makes a 370-yard round trip from the mill's soaking pit to the rolling mill along a track between the two departments.

Carrying a blazing load of ingots, the cart is propelled by a cable which runs between two drums at either end of the 555-foot long route. The cable is started by an operator in a remote control pulpit, and winds on one drum, pulling the cart to the further station. There the cart is positioned automatically and the ingots are loaded or unloaded. When the transfer is completed, the operator starts the cable rewinding onto the other drum, and the cart is returned to the first station, where it again waits in precise position for the transfer operation. Use of a cable and drum system has eliminated downtime—formerly a problem with a self-propelled cart which was subject to electrical breakdowns.

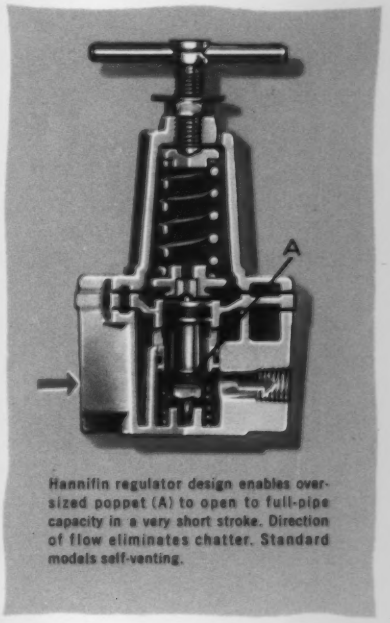
Circle 677 on Page 17

Circle 678 on Page 17→

From HANNIFIN *Crown* air preparation units that don't waste air power



Complete, compact, CROWN "matched units" available in any combination you may require, sizes ¼" through 1".



Hannifin regulator design enables oversized poppet (A) to open to full-pipe capacity in a very short stroke. Direction of flow eliminates chatter. Standard models self-venting.

Hannifin CROWN "Combo" units – filters, regulators and lubricators in any combination – keep compressed air in the "pink of condition" without depriving you of needed air flow.

Crown regulators open fast on demand, close precisely when demand is satisfied, deliver the exact amount of air needed. Their "piston balanced" poppet design, which makes possible a flat, large-area, poppet-type valve with very short stroke, is the reason. The inherent stability of this design – no hunting or chatter – results in multi-million cycle life.

Crown filters have large, reusable filter elements for minimum resistance to air flow. Crown lubricators introduce predetermined amounts of oil into the air stream, automatically. Their design is so responsive to variations in air flow rate that the concealed, tamperproof adjustment is rarely used. This is the easiest lubricator of all to fill, and remote-fill models are available.

Crown units are competitively priced and stocked in principal industrial areas by Hannifin CROWN authorized distributors. For CROWN literature and the name of the distributor nearest you, write:

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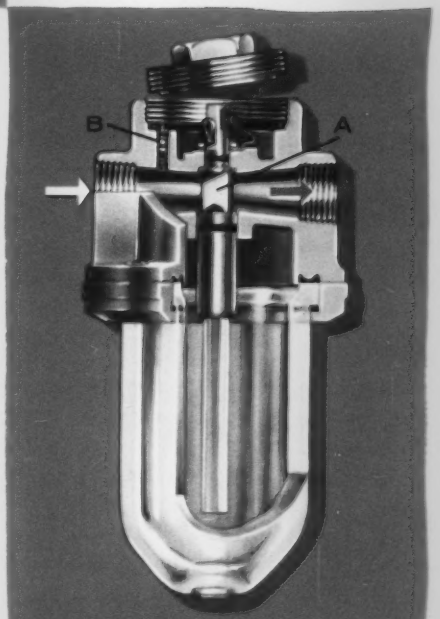
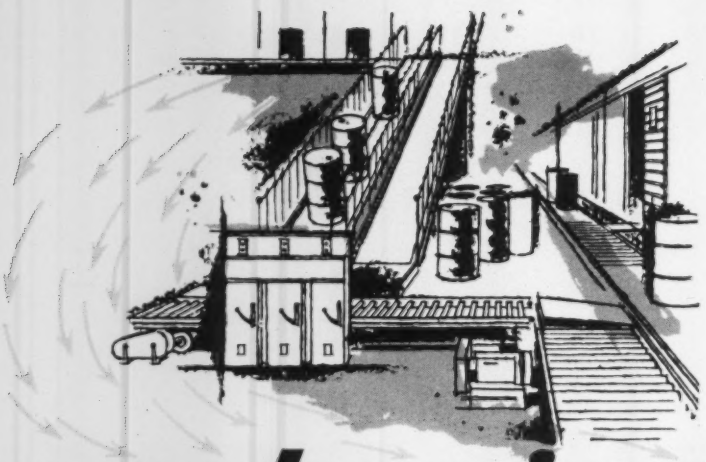
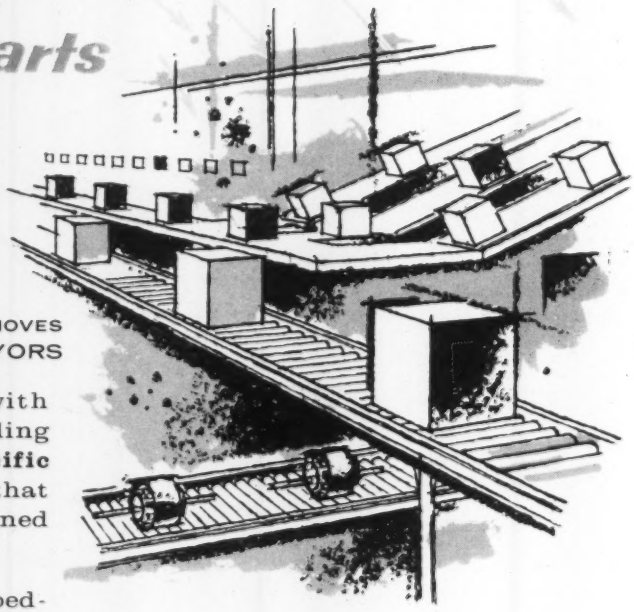


Lubricator vane (A) is factory pre-set for most applications. Valve (B) shuts off air pressure to bowl when fill plug is removed. This patented Hannifin feature permits bowl refill without shutting down air line.



synchronized

movement of materials and parts



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Circle 679 on Page 17

The Payback

Time and again we are confronted with the question of just how to evaluate the payback on automation realistically. This is a complicated problem and industry has all too often fallen into the trap of judging by the seemingly quick and easy method of payback in labor savings.

Payback period evaluation based on this method can be grossly misleading. It is of little value in studying the economics of a completely new automated plant or line. One line evaluated on this basis showed a two-year payback, but instead there was a three per cent loss—measuring actual profitability via return on investment as a yardstick. Another with an equally good payback showed an exceptionally high return on the investment.

For realization of the important competitive and economic objectives sought with automated systems, manufacturing management and equipment builders can make use of more reliable and more complete measurements of profitability than labor savings alone. Factors other than reduced labor, such as savings in raw materials, may offer outstanding opportunities.

Measurement of profitability is difficult and requires considerable effort. But economic gain from automation must not and cannot exist only in theory. To truly evaluate the long-term return on capital investment, it is necessary to avoid the arbitrary determination of a suitable payback period, and insure a solution grounded in objective fact.

Burden and machine depreciation costs assume a key influence in determination of unit manufacturing costs, and must be adequately considered in studying automation payback.

Evaluation by means of return on investment offers a superior measure that includes all relevant elements necessary to insure full dollar advantage with new processing advances.

EDITOR

AUTOMATION

DEVELOPING AUTOMATION FOR FLEXIBILITY OF OUTPUT

- ORGANIZING THE ATTACK
- STUDY OF OPERATIONS
- DEVELOPING THE HARDWARE
- DATA PROCESSING
- ECONOMIC JUSTIFICATION

Keys to a successful automation program are proper organization and close co-ordination of all management functions affected by the project. From the conception of the product design to the implementation of the manufacturing line, all phases of the automation program must be carefully studied, evaluated against each other, and adjusted to attain optimum results. A workable plan for establishing, developing, and applying an automation program is described in this series of articles which was presented at the Third Conference on Manufacturing Automation at Purdue University.

ORGANIZING THE ATTACK

By KEITH B. BENNETT, Project Engineer, Test Equipment Engineering, International Business Machines Corp., Endicott, N. Y.

ORGANIZING the attack on an automation problem is as important an element in achieving an eventual solution as the final system design itself. The particular organization plan, or method of attack, will vary widely depending upon the scope and type of problem, the personnel and skills available, and the time allotted for reaching a solution. However, there are certain common elements to be considered in attacking any automation problem, and a suggested plan of action that has worked successfully at International Business Machines Corp. is shown in TABLE 1. Key factors in determining the ultimate success of an organized automation effort are the wise selection of personnel to work on the problem, effective use of engineering talents on various phases of the problem, and a clear, methodical approach toward its solution.

Define the Problem

To best define what method of attack should be used, it is first necessary to clearly define the automation problem to be solved. Of prime importance is a definition of what processes or operations are to be considered for automation. Next, the objective of proposed automation should be clearly defined. These objectives may be of single purpose such as cost reduction, higher output volume, elimination of toilsome or repetitious jobs, improved quality or process control, or the objectives may be combinations of purposes.

A final area of definition is the limits to be placed on studying and designing the ultimate system. In most cases the introduction of automation into an existing organization will affect many areas beyond the particular manufacturing area involved. Production control, purchasing, quality control, assembly, raw stores, and accounting are some of the allied functions which may be affected by the introduction of a single process of automation. How many of these areas must the systems designer take into consideration? By specifically defining these limits, the designing organization can be given a relatively clear frame of reference in which to work.

An automation problem recently studied by IBM can be used as an example of problem definition, and as an illustration of a typical organization method used for problem solution. Basically, the problem was this: How to automatically insert electronic components into printed circuit cards in high volume. Approximately 360 different types of circuit assemblies were to be manufactured, requiring insertion of varying numbers of approximately 500 different types of components. Manufacturing was to be in relatively small lots of each circuit type. Frequent setup changes would be necessary to accommodate small lot, high-mix production. Ultimate production would be several million finished circuits per year.

When this problem was presented to a group charged with designing the insertion system, the following problem definition was given:

1. The process to be considered was the automatic insertion of components into printed circuit cards.
2. The objective of the proposed automation was primarily cost reduction. It was possible to assemble the required volume by hand, but costs would be prohibitive.
3. The scope, or limit, of the problem was to consider the handling of cards and components from the stock area through the finished insertion process. Design of the system had to allow for the time required by administrative and

TABLE 1

Basic Steps In Attacking An Automation Problem

1. Define the problem requiring automation and outline the objectives desired.
2. Gather data on production requirements, cost, product engineering, financing, and administration from all areas concerned with the automation project.
3. Define the required capabilities of the system and logically divide the system into its elements.
4. Develop system criteria to be used in evaluating the design concepts.
5. Develop points of judgment for system elements.
6. Weigh ideas for each element against points of judgment.
7. Combine selected elements into a system.
8. Judge the contemplated system against the system criteria.

support functions, but not detail or consider their functions. The insertion system had to be compatible with succeeding manufacturing operations (soldering, cleaning, testing, etc.) but these operations were not to be designed.

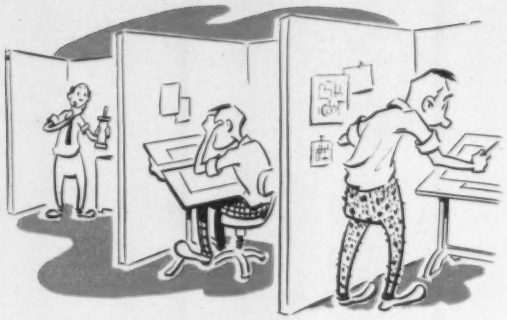
With the problem thus defined, it was possible to organize a group to study and design the required automated inserting system. The "task force" type of organization was selected.

Organize a Team

Prior to the organization of the task force, three IBM plant organizations had independently been developing automatic component inserting equipment. Thus, three different systems were in existence. The primary assignment of the task force was to study the three systems; determine the best features of each; merge the selected features into a new, integrated system; and outline design specifications for those areas requiring new or additional design.

The task force was composed of two engineers from each of the three plants. Selection of these personnel was based on the following criteria: They must have demonstrated engineering judgment; they must have thorough knowledge of the systems developed in their particular plants; they must not be prejudiced in favor of their particular system. The latter two criteria are of tremendous importance. Without a knowledge of the existing system, the task group would be faced with a tremendous educational problem. Had the members of the group been strongly prejudiced in favor of their plant's system, nothing more than a long series of defensive arguments could have resulted. Considerable engineering integrity is often required to allow an engineer to vote against his own creation, and in favor of another's ideas.

One member of the six-man task force was designated to act as chairman. His responsibility was not to direct or run the group, but to act as a moderator,



. . . no attempt was made to "brainstorm" possible solutions because of the desire of the group to limit itself to considering developed technology . . .

and to keep the discussions continuously directed toward the immediate objective. With six engineers working on a common problem, the natural tendency is to drift into "inventing" sessions, and to lose sight of the over-all systems design objective. It was the chairman's job to minimize these occurrences.

The success or failure of such a task force depends in large measure on the sense of responsibility which the members feel, and on the authority given the group. All too often, this type of organization has failed because the group knew that their decisions and recommendations could be negated by anyone of greater authority—and all too often by someone not familiar with the problem. In this frame of mind, the group has no real impetus to perform diligently, and no real sense of pride in their work, as they feel that the final responsibility is not theirs.

In the case of the IBM task force, the full responsibility was placed squarely on them. At its inception, the group was told by senior management, "You design the system the way you feel it is best, and that is the way the system will be built, regardless of the feelings or opinions of management or anyone else." With such a vote of confidence, and with such a feeling of responsibility, the task force group automatically gave serious consideration to each decision, and generated appreciable pride in the system they were developing.

Commensurate with its responsibility, the group was given authority. All plant facilities were placed at the group's disposal. The authority to practically subpoena "witnesses" was granted the group, and co-operation of all concerned was insisted upon by senior management. The authority to summon witnesses was a valuable aid in undertaking the first of the task force's major steps—information gathering.

. . . it is necessary for any design task force to gather considerable data from all areas concerned with an automation project . . .

Accumulate Background Data

Regardless of the limitations on the scope of the problem to be considered, it is necessary for any design task force to gather considerable data from all areas concerned with an automation project.

Questions on production requirements, cost, product engineering, financing, and administration must be answered if the ultimate automation system is to satisfy all its diverse requirements. The answers to the questions are best obtained by direct interrogation of those most immediately familiar with them.

This approach was followed by the IBM task force. People regarded as expert in their respective fields were called in and questioned at length by the group members. This type of interrogation served to gather valuable correlative data and to completely acquaint the group with all aspects of the problem. All of the data gathered were permanently recorded on a standard office machine into the daily minutes of the group. These minutes formed a running account of progress and an invaluable reference record.

Having gathered the necessary background data and digested them to the point of understanding, the task group next came to grips with the actual system design problems. The task force used a three-point method of attack to begin its considerations which included a definition of required system capabilities, logical divisions of the system required, and development of criteria to be used in evaluating the design concepts.

▶ Analyze the Design Problems

The basic capabilities for the insertion problem might be defined as the ability to perform the required number of insertions, at less than a defined maximum unit cost, with the capability for maximum flexibility and rapid adaptation to changing product mix.

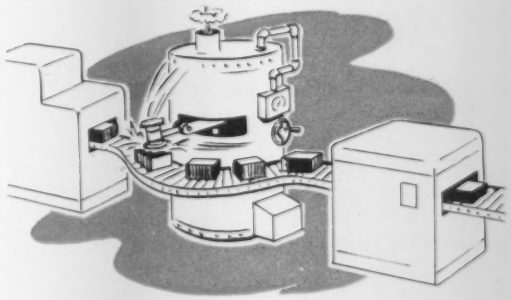
The logical divisions of the system, each to be considered separately, were developed from the elements and functions known to be necessary to satisfy the required capabilities. The divisions were component preparation, component pretesting, machine component inventory, component transfer to insertion, printed card handling, insertion tooling, rework and repair, testing, and machine control and monitoring.

Prospective designs for each major portion of the system were weighed against a set of common criteria developed to insure conformity to system requirements. These criteria were: 1. Adaptability to scheduling changes. 2. Expandability. 3. Adaptability to continuous monitoring. 4. Minimum exposure to failure due to lack of components or circuit cards, mechanical and/or electrical failure, or excessive technical skill required for operator. 5. Minimum complexity of control and error detection system. 6. Capability to utilize existing designs. These criteria were kept in mind during development of system elements, and were used in judging the completed system.

The specific capabilities, divisions, and criteria used in an automation problem will depend entirely upon the problem itself. However, the general approach of broadly defining the system's required capabilities, dividing the system into its major elements, and developing a set of "primary standards" in the form of system criteria is applicable and useful in attacking any problem. This type of organization will simplify and expedite the development and evaluation of designs for various portions of the system.

▶ Weigh the Designs

Once the system has been logically divided and over-all criteria established, the specific design of the various system elements may be started. With several engineers working together, there are bound to be many ideas presented for the design of each system element. Some means must be used to judge the relative merits of each idea. The criteria established previously for the system provide a good general framework, but must be further broken down and detailed for judgment and comparison of design ideas on specific problems. Listing the important points of judgment, assigning relative weights to them as required, and comparing the ideas generated on the basis of these points provides an excellent means of determining the relative merits of each proposal.



. . . some design concepts, which appeared soundest when viewed individually, may no longer be so appealing when viewed as a portion of a complete system . . .

For example, in the insertion problem it was necessary to select a means of propulsion for a positioning table which would hold and move the cards to programmed positions during the component inserting process. The positioning table had to move in the X and Y axes and be very precisely controlled. The types of motive power devices considered were electrical-servo, pneumatic, and pneumatic-hydraulic. These three alternates were compared on the following points: 1. Cost. 2. Ability to achieve minimum required increment of movement. 3. Accuracy achievable. 4. Speed. 5. Reliability. 6. Durability. 7. Ease of maintenance. 8. Ease of unit interchangeability. 9. Complexity of input power and control. 10. Ability to use available commercial parts. 11. "Fail safe" capability. 12. Freedom from noise. 13. Stability. After careful consideration, the group determined that, for this application, the pneumatic drive system had a clear superiority in 9 of the 13 points, was equal to the other systems in 3 of the

13 points, and was at a disadvantage only in the area of noise. On this basis, the pneumatic drive was selected. Similar approaches were used on all major design problems within the system.

The generating of ideas to be thus evaluated was done on an individual basis. No attempt was made to "brainstorm" possible solutions because of the desire of the group to limit itself to considering developed technology. Rather, each of the six engineers generally thought up his own ideas, and presented them to the entire group. All ideas were then considered and weighed, with considerable discussion and debate. In many instances, the similarity of these independently conceived ideas clearly indicated concepts on which there was consistent agreement, eliminating the need for much exploration and debate. The system developed was the composite and integrated sum of the solutions to individual problems, such as the example given.

Combine Elements into a System

Having arrived at solutions for each of the major areas, the design group must combine all the design concepts into a workable system. Here, some decisions may have to be reconsidered. Some design concepts, which appeared soundest when viewed individually, may no longer be so appealing when viewed as a portion of a complete system. There may be incompatibilities among adjacent or connected system elements. The material transport system, for instance, may not be ideally suited for operation with the best component inserting device. When these conflicts occur, compromises must take place. Any system is bound to contain compromises between the ideal and the practical, between the perfect and the expedient.

Synthesizing the system to check for compatibility and need for compromise provides an excellent check for over-all adherence to the initial system concept and parameters. At this point, it is well to judge the total system against the previously defined criteria. Failure to satisfy any of these criteria indicates system weakness, and the necessity for further consideration. When the system design meets all the criteria, there is a reasonable certainty that it will perform all of its intended functions in the manner anticipated.

Evaluate the Results

When a system design group has completed its work, the detail design of the individual system components must begin. In order to provide designers with the total system philosophy, and with the reasoning behind the design concepts, a detailed report should be prepared by the task force. The source of this report should be the detailed daily minutes of the task group meetings. Organizing and condensing these minutes should provide an accurate and detailed final report with a minimum of additional effort. After the system has been operative for a reasonable length of time, its performance should be carefully evaluated. If it is found to be deficient in any areas, the decision must be made whether the system design was at fault, or whether the execution of the design concepts was faulty. The complete final report will be an invaluable aid in such post-operative evaluation.

The general techniques described have been found effective at IBM. This approach to organization may not result in the fastest solution to a system design problem, but it certainly results in a thoroughly considered solution. The use of the eight steps outlined in TABLE 1 guarantees careful analysis of every system element. With proper personnel selection for the task force, and with the proper backing of responsible management, this type of organization and approach should result in the design of an automation system capable of performing its designated functions.

DEVELOPING AUTOMATION FLEXIBILITY

STUDY OF OPERATIONS

By **GEORGE PHILIP**, Project Engineer, Manufacturing Research, International Business Machines Corp., Endicott, N. Y.

IN ANY PROJECT in which automation techniques are to be considered as a major portion of the manufacturing process, the entire scope of an operation should be studied and analyzed. In this study it is not uncommon to be confronted with a large variety of topics consisting of technical, economic, and management factors. Engineers seem to favor the technical challenges, leaving the other factors to dangle as a sort of tail end consideration. Occasionally this tail end has wagged an organization at the most critical and inappropriate times, and the importance of planning and economic factors became apparent. It is usually wasteful to start engineering for technical details before the whole problem of manufacturing a product is well understood.

In any system that is required to produce a product, both the immediate and the long range production requirements must be examined. Usually, production requirements are based on sales forecasts.

From these data a "rate of production" curve can be developed which will indicate the level of productivity the system has to reach and how much time is allowed for it to achieve this level, *Fig.* 1. If pilot production is already under way, tie-in with that system should also be considered. The predicted lengths of the production forecast should also include an estimate of the longevity of the product and when major changes in the product can be expected. This particular point can influence the degree of sophistication to which a system can be economically built. Taking the above factors into account, a minimum daily system rate can be developed which will then place certain immediate restrictions on the system.

▶ Develop A Flow Chart

Once the general scope of the project has been established, design approaches should be considered to develop a flow chart showing the sequence of operations. This is a good time to apply creative thinking techniques on a small group basis. System criteria, which have been previously established, combined with production requirements, should be reflected in each step of the sequence flow chart. After each individual scheme has been evaluated, a final concept can be blended, using the best features of preliminary charts.

The final flow chart should spell out each process step in general terms and should include provisions for receiving of materials, in-process storing, secondary preparations for manufacturing operations, manufacturing operations, testing, and shipping, *Fig.* 2. The flow chart can be considered as an over-all aid in developing the system concept and requirements for each indicated area. These requirements directly reflect the production requirements, embrace the previously established organization criteria, and spell out some technical guidance for subsequent design. The following factors are significant in establishing a system concept: Production requirements, component handling, maintenance, controls, and programming.

▶ Analyze Production Requirements

Of prime importance are production requirements —how many pieces must the system produce per unit of time. Next, each of the areas indicated in the flow chart has to be examined for conformity to its probable production rate. Many promising tooling approaches may have to be abandoned because the stipulated production requirements cannot be fulfilled, because the mechanisms required to support the operation look too complex, or because projected design and build costs seem too high. After local production rates have been established, special requirements for the system are another factor to be established. Ability to perceive the mechanical problems in terms of high speed mechanisms is of great help here. Sometimes it may be more prudent to develop two simpler, slower systems than one complex, but faster, system. This thought can be further examined when longevity considerations of the system and mechanism are included. Slower systems can be built more ruggedly and hence may not fail as easily or wear out as rapidly as the higher speed mechanism. However, the life expectancy of high speed mechanisms can still exceed the life of the production run. An optimum solution can generally be found to guide this decision.

Component handling ability is also a major concern. The rate of component delivery must be matched with the requirements of the insertion mechanisms. It would be wasteful to have a machine sit idle while waiting for components to arrive.

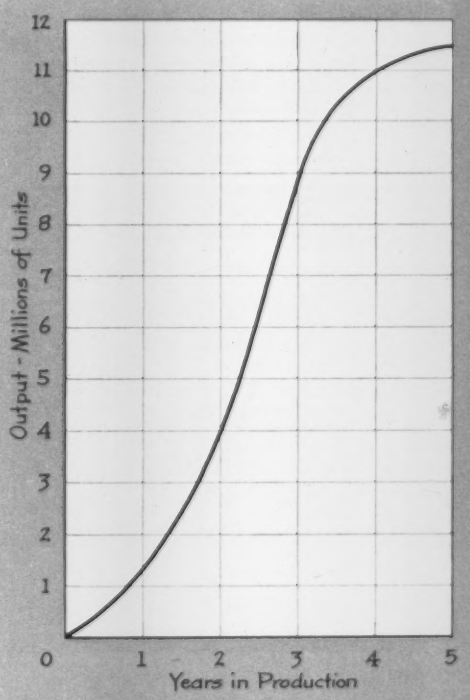


Fig. 1—Rate of production curve developed from projected sales forecasts indicates the level of productivity a system has to reach and how much time is allowed for it to achieve this level.

Another area of consideration is the problem of supplying components to the automated machine making the product. Not only must the specific components be available at a given time, but they must also be added to the machine without incurring excessive downtime in the cycle. For maximum efficiency the machine should be designed so that a large number of components can be added for the

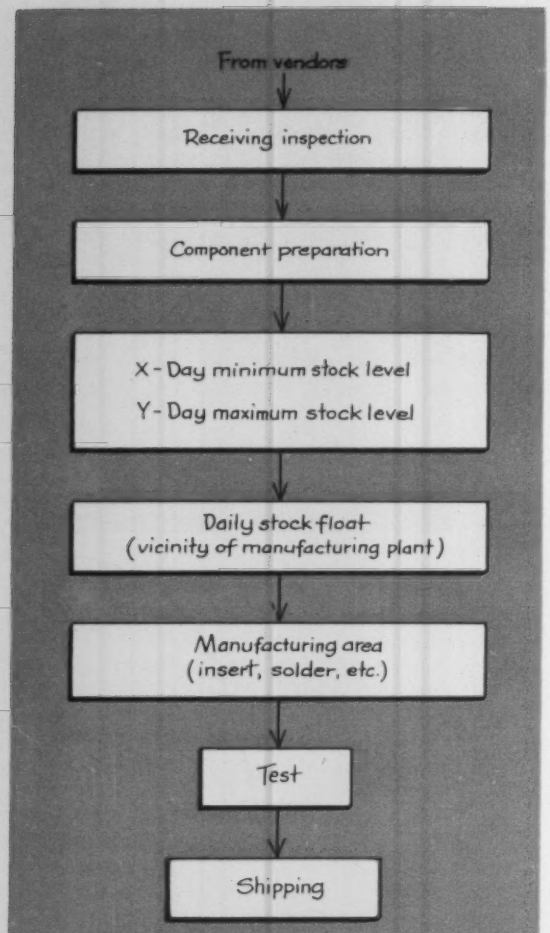


Fig. 2—Sequence flow chart reflects the system concept used in defining requirements for a proposed automation project.

next production order while the machine is engaged in finishing an existing production order.

▶ Consider Maintenance and Control

As the general outlines of the system begin to firm up, it becomes necessary to consider maintenance requirements. From previously compiled production data, the cost of downtime on a time-unit basis can be evaluated, and its effect on the operation predicted. In most cases it is imperative to keep nonproductive time to a minimum. It becomes prudent at this time to think in terms of maintenance requirements and to consider only those mechanisms and designs which have good maintenance characteristics. Standard mechanisms, unit construction, simplified circuits, and ready accessibility to mechanisms are considered as desirable design criteria. Maintenance logistics problems should be studied, and items such as replacement part storage, availability of key mechanisms, and over-all complexities should be included in this approach.

Controls play a major part in the system concept. After the general image of the machine system has been firmed up, the next step is to select a control system to give the best service in terms of the previously established criteria. This selection of a control system is tempered by how much money can be spent to provide optimum over-all performance. There are many types and forms of controls, ranging from simple *ON-OFF* devices to complex programmed systems. They begin with each separate mechanism, expand to each machine system, and extend to the over-all control of the operation. Data handling, scheduling, and controlling considerations should be taken into account for each sequence.

Decisions should be made as to the extent programming is to be used, how much real-time synchronization is to be included, and how much flexibility is desired. In some systems, it is economical and effective to use card and tape programs, unit controllers, sequential operation cycles, and monitoring of the production capability of each machine. Card programs are effective since a complete program for a production order could be stored on a single card. This greatly simplifies the problem of physically storing and maintaining program libraries with respect to engineering changes or other alterations. Tape storage requirements are much greater, and tape programs are not as easily serviced as card storage programs. The use of program libraries at each machine simplifies production control activities and does not require that each order be accompanied with its individual program. Since individual orders can be programmed on relatively few cards, this reduces the amount of data that have to be available for any given day.

The use of unit controllers allows each machine system to operate at its own speed and capacity without tying everything together into a very complex central system. Grouping of more than one machine with a controller is also possible but depends on the complexity of the process and requires careful consideration.

In order to maintain quality of operation in the system, sequential operation of the machine should be specified. This permits early detection of malfunctions of the machine and also makes possible monitoring for production capacity, capability, and rework.

While making all these considerations, one thought continues to haunt the system analyst. He is usually technically well informed and aware of new developments and things that are under development in his company. He is constantly tempted to include in his system developments that are not readily available, but which he feels might be ready in time for the planned system delivery date if extended effort is applied. He is torn between weighing pessimistic design considerations and optimistic declarations of his engineers. However, the system that he is to build must be available at a specific date to meet the production requirements. This forces him

to narrow the choice to what is available now in the majority of decisions and what is in design for only exceptional cases.

▶ Combine Units Into System

After the best system concepts have been established for each operation and sequence, they are put together in what can be called the optimum system. This system might not necessarily be the best from the controls system engineer's point of view or the materials handling concept or the production control or machine design aspect. It is, however, the best approach to a system developed against the background of production data. It is the best system for the job it has to do.

Before this concept can be turned over to the various designers, the machines in the system must be integrated to allow a smooth, flexible flow of the material in the operation. Machine loadings should be analyzed, and each individual system should be balanced against the output of the preceding one. Generally, a 10 to 20 per cent overcapacity is permissible. It is often wiser to let a machine remain idle for a while than to be always crowding in full production capacity. A schedule that always loads a machine to full capacity allows little flexibility for production changes, is dangerously overexposed to system downtime, and in the long run, will not fulfill daily production requirements. The arrangements of machines, component handling equipment, and component storage should be considered in terms of machine output, accessibility to maintenance, catastrophic failures of scheduling, and other local intangibles.

In line systems, arrangements should be judged against parallel systems. Combinations of them should be tried and balanced out against manpower requirements. When less people are placed in routine operations, better system performances can be obtained. However, some decision-making functions can generally be done more economically with people than with machines. The cost in complexity of a complete automation system often negates the economic advantage when reflected against product life. Routine operations, however, should be as fully automated as possible to gain economic advantage, flexibility, and production performances.

A final general layout will sum up the entire operation in terms of the previously discussed criteria and will serve as a road map for detail specifications. These detail specifications should be concise, but not so restrictive that a designer has no freedom to exercise his own ingenuity. The specifications should spell out the objective of each function and perhaps offer some guides, but should not further influence the designer.

DEVELOPING AUTOMATION FLEXIBILITY

DEVELOPING THE HARDWARE

By **ALFRED H. JOHNSON,** Project Engineer, Manufacturing Research, International Business Machines Corp., Endicott, N. Y.

THE ESSENCE of good product design is simplicity. This simplicity of design lends itself to automation, and automation can be furthered through its use. The effort devoted to product design for ease of manufacturing should be proportional to the expected cost of manufacture. For example, a reduction in direct manufacturing labor time of one second per assembly would realize a saving of $16,000 on a yearly production of one million assemblies. Obviously, considerable design effort would be justified if it resulted in manufacturing time saving on such high quantity items.

It is perhaps paradoxical that as the complexity

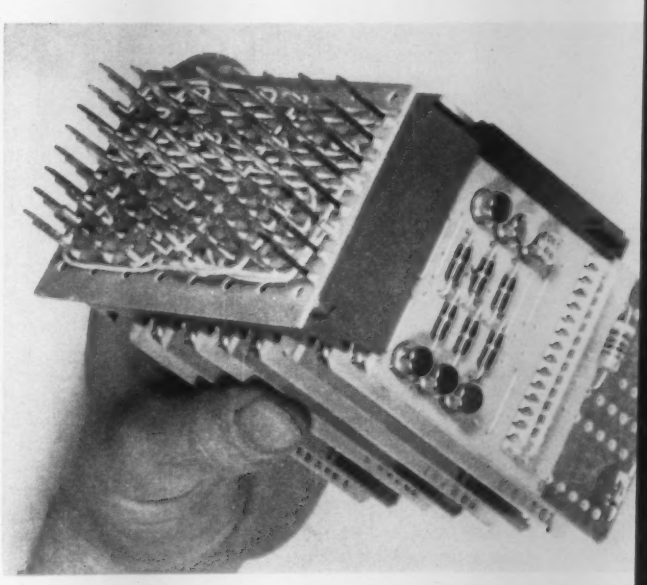


Fig. 1—All components in this module used in computer construction have been standardized. By varyingg the component layout on the printed circuit wiring boards or by varying the interconnections between wiring boards with the printed circuit terminal board, many combinations of transistor circuits can be made from the standardized elements.

of an automated production line increases, the design of the product made on the line must be simplified. This simplified product design is often found to be more effective in meeting its design objective and usually would have reduced the cost of manual assembly.

Importance of Product Design

It is often stated that the key to automation is high production. The feeling is widespread that, given high enough output, any production line can be automated. While theoretically true, this concept is impractical unless sufficient attention has been paid to design of the product produced on the line. The cost of tooling for either partial or complete automation of a particular part or assembly is very dependent upon its design. As a result, the production quantities at which the cost of automation equipment becomes justified are also dependent upon design. The benefits of low cost associated with automation can, by good product design, be realized even for low production quantities.

A design for a product which is difficult to manufacture is often accepted by the manufacturing division on the basis that low production quantities are expected. It frequently happens that these production quantities increase. Product redesign would result in loss of standardization, additional product testing, and higher tooling expense. For these reasons, the manufacturing division is often forced to live with a poor product design. This condition can be avoided if the product designer considers manufacturing aspects when making the original design.

The manufacturing engineer should also be concerned about the design of the product for he has the problem of tooling the production line. If he feels he has no business concerning himself with designing the product, he has no right to complain about the design. If the manufacturing engineer waits for an invitation to consult on product design, he is apt to be ineffective in obtaining needed design considerations for automation. The manufacturing engineer must play an active role in product design.

The manufacturing engineer can be expected to design with greatest emphasis on manufacturability. The product design engineer will be primarily interested in satisfying functional requirements. Combining designs developed under these two outlooks can result in a highly effective single design.

An example of a product whose design has been strongly influenced by manufacturing considerations is the IBM Standard Modular System, a transistorized computer package system. Corporate management was well aware of the importance of carefully integrating performance requirements with manufacturability. Manufacturing Engineering personnel played an important part in its development and actually were in direct design competition with Development Engineering.

Standardization of Computer Components

The Standard Modular System is based upon standardization and automation. Since the modern solid state computer can vary considerably in size as well as speed, it is composed of a variety of different circuit elements. Mass production of these circuit elements is not practical since computers are produced in quantities of tens and hundreds rather than in thousands or millions. Therefore, the economies of automated production can only be realized by building these computers with combinations of small, standardized units. To obtain the needed flexibility when using standardized units, either the unit or its interconnection with others in the system must be variable. In the Standard Modular System, variations of both the unit and its interconnections are made largely by automatic programmed assembly.

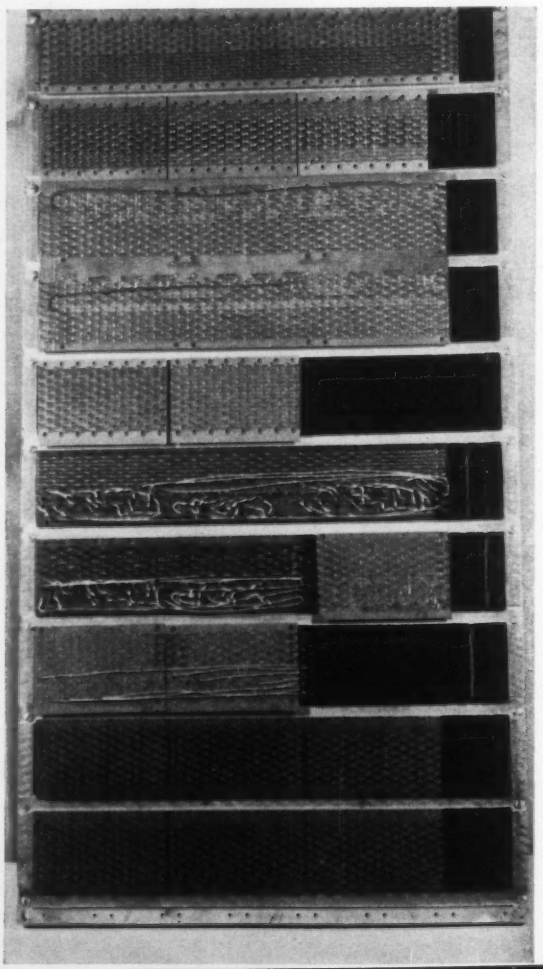


Fig. 2—This assembly of modules illustrates the versatility of the basic module design. Although the basic module accommodates eight printed circuit wiring boards under a single printed circuit terminal board as shown in the lower part of the frame, an interconnected chassis of any size can be constructed by combining 2, 3, 6, or more basic modules under a large printed circuit terminal board as illustrated in the upper part of the frame.

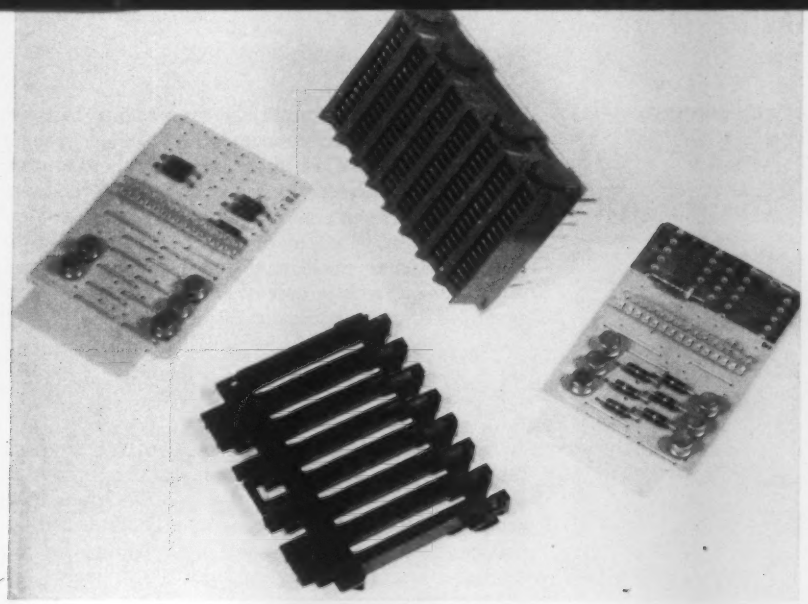


Fig. 3—The standardized components of the basic 8-position module are the receptacle, top; printed circuit wiring boards, left and right; and the wiring board separator, bottom. Each of the components was designed to attain the maximum benefit from fabrication and assembly by automatic equipment.

A standardized unit or module used in the construction of computers is shown in *Fig.* 1. This module is constructed from various standardized components which have been specifically designed to facilitate automated production and assembly. These components include printed circuit wiring boards in which transistors, resistors, and other electrical parts are installed; an 8-position receptacle into which the wiring boards are plugged; a wiring board separator that holds the boards in perpendicular alignment with the receptacle; and a printed circuit terminal board that slips over the terminals projecting from the receptaele and furnishes means for interconnecting the various transistorized circuit boards. It can be seen that considerable flexibility has been designed into the module, for various combinations of transistor circuit boards can be grouped together and interconnected by installing different printed circuit terminal boards. Although the basic module accommodates eight circuit boards under a single terminal board, an interconnected chassis of any size can be constructed by combining 2, 3, 6, or more basic modules under a large printed circuit terminal board, *Fig.* 2.

Each of the components of the module was designed to attain the maximum benefit from assembly by automatic equipment. For example, the design of the printed circuit wiring boards, *Fig.* 3, was restricted by the following conditions: 1. Only one size board would be used. 2. The number of hole patterns was limited. 3. All components, except transistors, were to be mounted parallel to each other and also to the plugin side of the board. 4. Components were to be mounted in holes with either a 0.700 or 1.000 inch spacing. 5. Crossover functions were to be performed by tinned copper wire staples which would eliminate the requirement for a double-sided board.

Circuit design flexibility is provided by varying circuit patterns and by programmed component selection and placement in automatic assembly equipment. The restrictions imposed on the board size and the lead spacings have not been serious limitations to the circuit layout people. Actually, the resulting standardization has decreased circuit layout time by providing pre-made land pattern drawings. The circuit design limitations were developed to fit the circuit board to programmed assembly equipment which was developed before the product. The existence of assembly equipment had considerable influence on the product design.

The receptacle into which the circuit boards are plugged, *Fig.* 3, illustrates the basic simplicity of design which was prompted by manufacturing considerations. The V-shaped detent grooves appearing on the sides of each receptacle have been put there solely for manufacturing purposes. The grooves permit the exact positioning of the receptacles for automatic terminal location. Later, the grooves are also used to provide accurate module location required for automatic wire wrapping of the terminals.

The terminals of the receptacle are manufactured from rectangular wire, and this results in virtually no material waste. The design is such that the terminals can ultimately be formed or inserted in a single operation for low cost assembly. Many different designs of printed circuit terminal boards, *Fig.* 4, can be inserted over the terminals of the receptacle to provide various interconnecting plug board hookups. The uniform grid pattern formed by the terminals can be compared to the usual clusters of terminals found when tube sockets or most commercial circuit board receptacles are used. In these designs, the customary clusters of terminals make interconnections between terminals by automatic means impractical and require hand soldering. The uniform grid of the terminals permits the use of standard hole pattern printed wiring terminal boards for some or all of the circuits. It also eliminates the necessity of soldering connections, for the terminals are ideal for use with the more flexible wire wrapping techniques. In the near future it is planned to incorporate card controlled wire

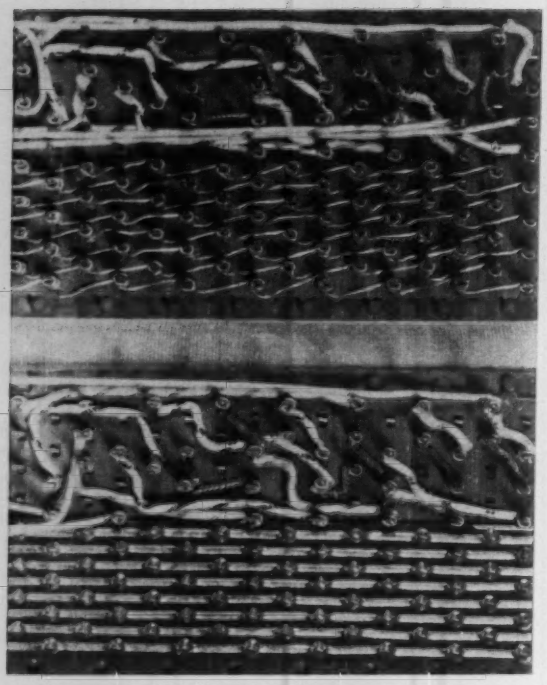


Fig. 4—This view shows two types of terminal boards that can be installed over the terminals of the receptacle to provide interconnections between printed circuit wiring boards. Many other variations of terminal boards are possible.

wrap machines to make the wire wrap interconnections. The interchangeability of the printed wiring terminal boards and advantages of wire wrapping permit using whichever technique is most economical for the flexibility required.

After individual modules have been assembled, they are grouped together into a subcircuit assembly by means of a standard die cast frame. Grooves molded into the sides of the receptacles are used to support and position the modules by engagement with extruded T-shaped bars which bolt to the die cast frame. Wire wrap interconnections between modules are normally made when the receptacles have been grouped in the subcircuit chassis form. For automatic wire wrapping of individual modules, each molded receptacle is located in a standard assembly pallet. This method of location results in greatly reducing the cost of the T-shaped bars and the frame assembly over their costs if they were depended upon for locational accuracy.

Other Design Considerations

The design considerations discussed are some of the many that have been made in the interest of manufacturability. Many other considerations have been made strictly in the realm of manufacturing. For example, in circuit board manufacture for the standard receptacles, sixteen individual boards are chemically processed as a unit. These 16-position boards are then divided into two 8-position units which are scored on both sides. After they have been assembled, soldered, and tested, they are easily broken apart for use. Considerable economies in handling are thereby effected and material waste is reduced to a minimum.

It has been found by experience that manufacturability must be considered in developing any new product, particularly if high quantities are expected. It is the responsibility of manufacturing groups to actively participate in product design activities. The attention paid to product design has resulted in considerably simplifying the job of manufacturing engineers. As a result, much automation equipment is in existence and already is reducing manufacturing costs in the early stage when production is largely used for engineering model requirements.

It cannot be expected that manufacturing considerations will solely determine product design. Obviously, this would result in a low cost product that might not work. Close co-operation and even at times competition between manufacturing and product design groups can result in simple, effective, and low cost products which are adaptable, through design, to automation.

DEVELOPING AUTOMATION FLEXIBILITY

DATA PROCESSING

By **WILLIAM E. ANDRUS JR.**, Manager of Applied Computation, International Business Machines Corp., Endicott, N. Y.

IN THIS ERA of automation, there is a definite trend towards a closer relationship between product designing and product manufacturing. This trend is being brought about by the use of automated design records which are generated on computers and data processing equipment in the engineering laboratory and are transferred to the manufacturing organization for continued processing during production. These design records contain far more information of a different

nature than is generally considered as data processing. In addition to the general component count and bills of material type of information, the records contain data which make it possible to "draw" logic diagrams on a computer and to update these diagrams from automatically checked engineering changes. They also contain data for direct digital input to automatic fabricating equipment, which can be automatically modified for engineering changes as required.

Within IBM, the generation of engineering design records is called Design Automation, or more properly, Design Mechanization. There are many phases of this activity which are primarily designed to serve the engineer and to relieve him of the tedious and noncreative functions commonly associated with product design. Such things as system simulation, automatic implementation of functional logic, and other such topics will not be discussed here, but rather the generation of the basic design "document," and its implementation into the manufacturing operation.

▶ Design Mechanization

Design Mechanization is primarily a process for the generation and maintenance of electronic design records. It consists of a series of computer programs written for the IBM 704 and 705 electronic data processing machines and is being used extensively in the development of the 7000 series machines in the IBM Product Development laboratories.

One of the inputs to the design mechanization system is data derived from sketched logic diagrams prepared by the engineer. These sketches are transcribed, key punched, and stored as a master digital record on magnetic tape. This becomes the basic input for further processing.

The first step in the system is a computer program which checks the input data for errors in logic design and generates an error list similar to that shown in *Fig.* 1. Three possible types of errors at this state are transcription and keypunch errors, format errors (those caused by the rigor of the system), and actual violations of design rules. The first two types of errors are corrected as far as possible before the error list is returned to the engineer. Along with the error list, the engineer also receives a machine generated logic diagram, *Fig.* 2.

This diagram, called an Automated Logic Diagram (ALD), is very similar to the original sketch submitted by the engineer. The logic blocks appear in the same location as on the sketch, as do the locations of the input and output signals. However, the lines interconnecting the logic boxes are machine generated according to a set of programmed line laying rules and are drawn in a semioptimum fashion.

When the engineer receives the error list and the ALD, he makes various corrections required by marking the ALD. The ALD is then returned to the computing center, and the additions and deletions are processed into the computer. The computer then updates the master record and generates a new error list, and produces an updated ALD with the corrections and changes incorporated. This process continues until essentially all design errors are eliminated.

As more and more pages of logic sketches enter the system, those pages relating to a particular chassis are checked with one another for conformance to the design rules. After all of the pages of a particular chassis have been entered and are essentially devoid of design errors, the computer

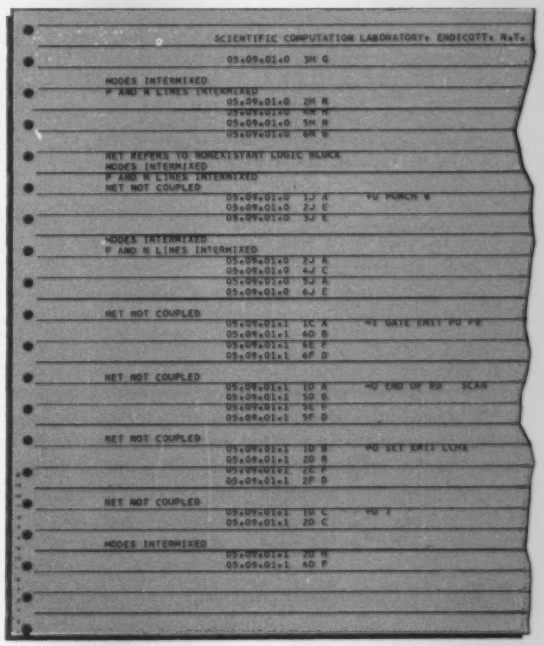


Fig. 1—After data derived from logic diagrams is transcribed and stored on magnetic tape, a computer checks the data for errors in transcription, format, and violation of design rules. An error list generated by a computer for a proposed system is shown.

then generates a wire list, as shown in *Fig.* 3. The computer selects the type of wire (single, twisted pair, or coaxial cable) and specifies the routing according to noise criteria.

Engineering changes which occur on a chassis that has been fabricated are readily handled by the system. Again, only the changed information is entered. The master record is updated, the chassis is rechecked for conformance to design rules, an updated ALD is produced, and an add/delete wiring list is generated along with a complete wiring list incorporating the changes. This makes it possible to incorporate these changes in chassis that have been fabricated as well as to build additional chassis with the changes incorporated.

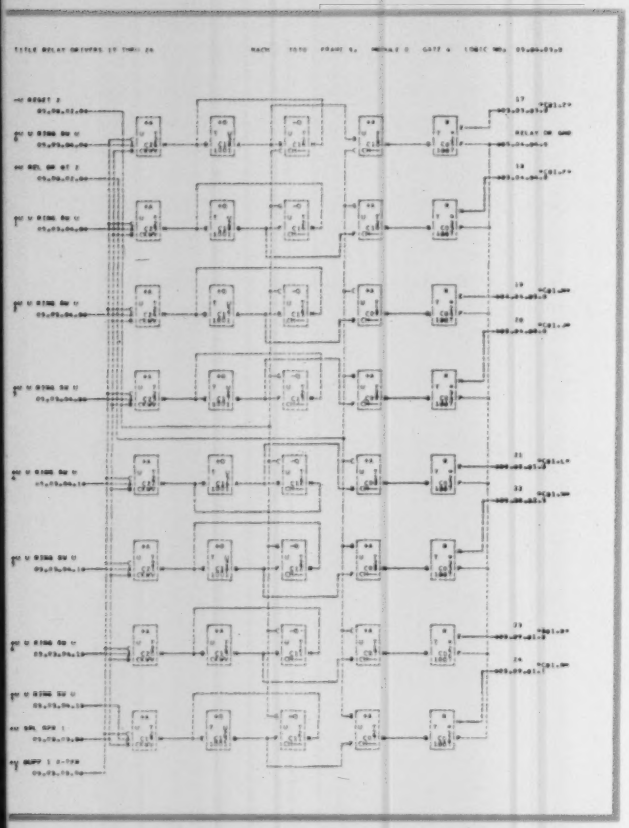


Fig. 2—Along with the error list, the design engineer receives a machine generated logic diagram which is similar to the original sketch submitted for computation, but which has programmed interconnecting lines.

Use In Manufacturing

When the design of a product is completed, it must be transferred to the manufacturing organization to be placed into production. This is generally called the release of a product from engineering to manufacturing. Rarely does a piece of hardware accompany this release. Generally, the release is in the form of a folder of documents containing the specifications of the components to be purchased or manufactured and the manner in which they are to be assembled. Such things as bills of material, specification drawings, and other such items are included in this material.

With the advent of automated design records, it is now possible to vary this release procedure. Certain records may now be transferred as a reel of magnetic tape, or a deck of punched cards, rather than as a paper document. For example, it is feasible to merge a separate input of hardware items, such as hinges, latches, frames, and nuts and bolts, with the electronic items on a single magnetic tape containing the complete bill of material file. Not only is this tape in a compact form, but it is readily adaptable by the manufacturing organization for the generation of its records; i.e., production scheduling, inventory control, etc.

A second item which now becomes feasible because of automated design records is the implementation of data to control automatic fabricating equipment. The data necessary to generate the wire lists with the design mechanization system are in a co-ordinate form, and their conversion into a form suitable to control automatic wiring equipment is rather trivial. Other methods are readily adaptable to the system.

In the design mechanization system the third stage of design is interchassis check and generation of cabling data. This cabling information may readily be converted to a form suitable to control automatic cabling equipment.

The engineering change activity on a product unfortunately does not end when the product goes into production. Changes begin to occur because of tooling requirements, as a result of cost reduction programs, and ultimately as a result of field experience as more and more systems are placed in operation. The phasing of these changes on equipment in all stages of production is compounded by the fact that data processing equipment contains many optional features which are selected by the customer to meet his own individual requirements. Thus, rarely are there two systems in the field with identical operational and physical configurations.

The control of changes under this situation becomes a serious problem. For example, before a special feature, called a sales change, can be installed on a piece of equipment, the change level of the machine must be known, and the machine must be brought up to the level required by the current change prior to its installation. This means that when the parts and instructions to incorporate the change are shipped, the parts and instructions for prior changes to bring the machine up to the proper change level must be included.

It is now possible to maintain a close control of the change levels and change activity for data processing equipment installed in the field. Master change control records are maintained on magnetic tape, and the change level of each machine is updated as various changes are incorporated throughout its life. A change control system of this nature can also generate the bills of material necessary to incorporate a particular change and can also automatically generate any additional bills necessary to bring the machine up to the proper level. It is also possible to select a machine by number, and automatically generate the entire "book" of logic diagrams for that system at its present engineering change level.

Design of Mechanical Components

The subject of automated records has been limited thus far to electronic systems and to electronic design and layout. One other area in which there has been considerable interest in the past is the design and automatic milling of cams. Input-output devices of data processing equipment are primarily

mechanical in nature, and cams are used extensively to develop the motions required to move punched cards and tape and to drive printing mechanisms and the like. As operating speeds of these devices increase, the design requirements of the cams involved become very critical and must be designed very precisely.

The IBM Product Development laboratories have, for a number of years, used computers to design cams and have developed a series of programs which provide direct inputs to an automatic cam milling machine. At the present time there are two series of programs, one for the IBM 650 and one for the IBM 704. The initial input to these programs is the velocity and displacement desired at the point of interest and the geometric configuration of the linkage. Entered with this information are functional characteristic curves selected for the particular case under investigation.

The computer generates the cam radii at any peripheral increment and in such a way as to give minimum accelerations to the associated mechanism. The individual radii are corrected for variation due to point of contact and the swing of the cam follower. Also, other items such as pressure angles and undercutting are determined as required. The cam radii are punched into tape which becomes the direct input to the automatic cam milling machine. The data processing steps for this procedure are shown in *Fig.* 4.

These programs have played a significant role in IBM's ability to develop reliable input-output devices. It would be impractical to run these devices at their present speeds without precisely designed cams.

▶ Standardization Is Necessary

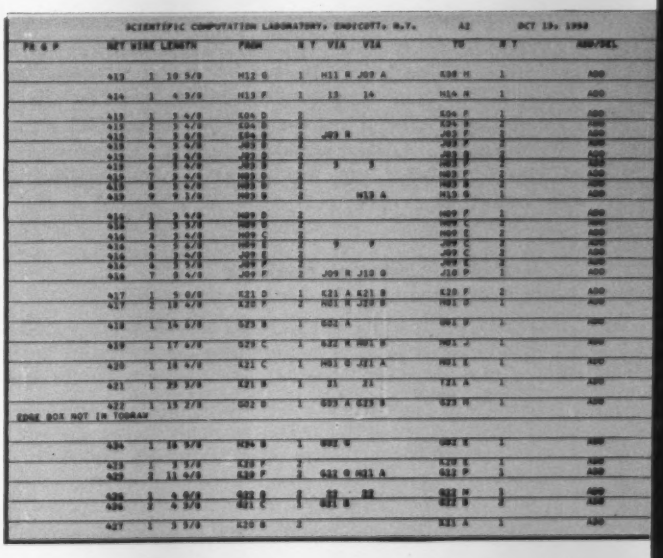
Standardization is one of the key factors that govern the success of a design mechanization system. Standardization in this sense is not the flexible circuit and component standards usually connoted by this term. In effect design mechanization is specifically planned to expedite the adoption of new circuitry techniques and components and in no way requires a static design activity. The stability of the electronic package, however, is a significant factor because major changes in the chassis back panel size or changes in the chassis configuration within the system can cause major programming changes.

The Standard Modular System which has recently been adopted by IBM is a flexible packaging system for the new 7000 series transistorized computers and satisfies the stability requirements of design mechanization. The basic component is a printed circuit card, which plugs into a standard chassis or panel. The standard panels are packaged into one of two standard modular frames. By selecting appropriate quantities of modular frames, data processing systems, from the smallest to the largest, may be packaged with one common packaging system.

The advantages of design mechanization have been manifold. The automated logic diagram and supplemental material generated with it satisfy the design, manufacturing and service requirements where, in the past, three separate diagrams were required. The time to check out or "debug" a fabricated chassis has been reduced in some cases by as much as 20 to 1. The overall development time to design an electronic system has been significantly reduced, and the quality of the design has been enhanced considerably.

Design mechanization, on the other hand, has posed some problems. The progress of a design group many times is measured by the quantity of hardware that has been built. However, under a design mechanization philosophy, construction is delayed until the system is essentially error-free. This, of course, tends to cause a misconception of progress. However, an important point is that it becomes quite feasible to plan the purchase or manufacture of components and to begin tooling early in the development program, even before an engineering model has been constructed.

Design mechanization and its extension into the manufacturing organization is but one of the tools which will enable industry to produce the quality and quantity of engineering required in the future with the limited manpower that will be available. It is the process by which a product can be placed into production rapidly with data to control not only the fabricating equipment, but also the pro-



SCIENTIFIC COMPUTATION LABORATORY, ENDICOTT, N.Y. A2 OCT 13, 1958

PR # P	WIRE LENGTH	FROM	# T	VIA	VIA	TO	# T	ADD/DEL
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	414 1 4 3/8	H13 F	1	13	14	H14 M	1	ADD
	415 1 5 6/8	K04 D	2			K04 P	1	ADD
	416 2 5 6/8	K04 B	2			K04 R	2	ADD
	415 3 5 6/8	K04 R	2	J03 R		J03 P	3	ADD
	419 4 5 6/8	J03 R	2			J03 P	4	ADD
	415 5 5 6/8	J03 Q	2			J03 Q	5	ADD
	419 6 5 6/8	J03 Q	2	5	5	J03 Q	6	ADD
	415 7 5 6/8	H03 D	2			H03 P	7	ADD
	415 8 5 6/8	H03 D	2			H03 P	8	ADD
	419 9 9 3/8	H03 R	2	H13 A		H13 G	1	ADD
	415 1 5 6/8	H09 D	2			H09 P	1	ADD
	416 2 5 6/8	H09 B	2			H09 R	2	ADD
	416 3 5 6/8	H09 C	2			H09 Q	2	ADD
	416 4 5 6/8	H09 E	2	9	9	J09 C	2	ADD
	416 5 5 6/8	J09 E	2			J09 C	2	ADD
	416 6 5 6/8	J09 F	2			J09 E	2	ADD
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	417 1 9 0/8	K21 D	1	K21 A K21 B		K20 P	2	ADD
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	419 1 17 6/8	G23 C	1	G22 K H01 B		H01 J	1	ADD
	420 1 18 4/8	K21 C	1	H01 Q J21 A		H01 K	1	ADD
	421 1 23 5/8	K21 B	1	21	21	K21 A	1	ADD
	422 1 15 2/8	G02 B	1	G03 A G23 B		G23 N	1	ADD
EDGE BOX NOT IN TOGRAM								
	424 1 16 5/8	H24 B	1	G02 G		G02 K	1	ADD
	425 1 5 5/8	K20 F	2			K20 K	1	ADD
	423 2 11 4/8	K20 F	2	G22 Q H21 A		G22 P	3	ADD
	426 1 5 5/8	K21 B	1	22 22		K22 N	1	ADD
	426 2 4 3/8	K21 C	1	K21 B		K22 B	2	ADD
	427 1 5 5/8	K20 B	2			K21 A	1	ADD

Fig. 3—After all pages of logic sketches for a particular chassis design have been transcribed and edited by the computer, the unit then generates a wire list. This list contains fabricating information for wiring a particular chassis. These data include the length of wire required, the routing on the chassis, and the termination points of each wire.

duction and inventory requirements. Best of all, it tends to eliminate the routine repetitive and noncreative activities that the engineer has been faced with for many years. He may now engage in activities more commensurate with his education and training. In its present form design mechanization is just the beginning of an automated process which will benefit not only manufacturing, but also product design and development.

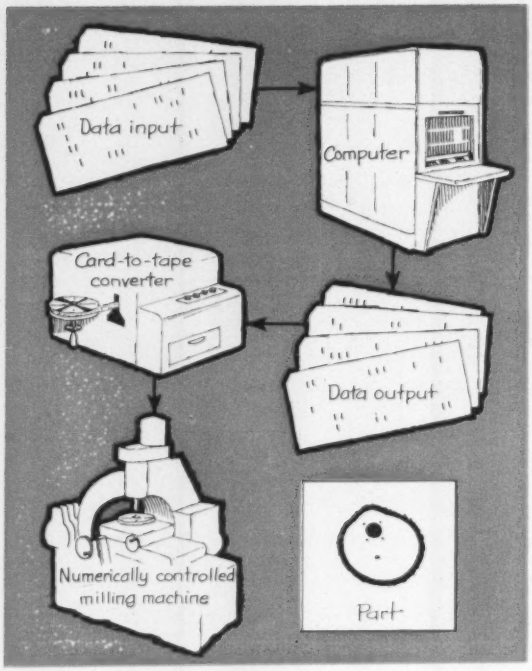


Fig. 4—Data processing steps for the design and manufacture of cams used in electronic equipment. A computer is used to generate the cam radii in accordance with the design requirements. These data are then checked, correlated with other factors such as pressure angles and undercutting, and punched into tape which becomes the direct input to an automatic cam milling machine.

ECONOMIC JUSTIFICATION

By **RICHARD D. SEILER,** Technical Assistant to Manufacturing Engineering Manager, International Business Machines Corp., Endicott, N. Y.

THE SOLUTION of any manufacturing problem is based on economics. The type of solution is dictated consciously by production requirements and more or less subconsciously by previous experience. An automation approach to a problem must be justified in terms of final cost of product. It is usually accomplished by replacement of manual operations for purposes of extending the capability of the human operator, incorporating more activity into an operation, and increasing quality of product and consistency of that quality.

The Financial Package

Market research reports and production schedules indicated that if a standardization program such as the Standard Modular System were to succeed within IBM, a highly automated manufacturing approach would be required to achieve the cost targets established. True, the equipment for such a corporate production program would be expensive, but the cost was judged to be not out of proportion when distributed over the total number of units to be produced. This conclusion required estimating all manufacturing tooling requirements on a five-year basis. The estimation problem was made easier since the manufacturing engineering personnel were able to place a pilot automation facility into operation within a relatively short period of time. On the basis of actual costs developed on the pilot line, a more accurate and realistic tooling bill was compiled for a full automation program to meet projected requirements. Because the required manufacturing techniques were at a reasonably high technological level at the time of acceptance of the modular system program, the determination of tooling costs presented no special problems other than the usual detailed analysis normally required when costing any such job. With the tooling cost and capacity established, the cost engineering departments plotted the product cost of each item of the proposed production over a five-year period. This study pinpointed the time at which the ultimate cost of each item would be reached when produced by automated equipment.

Based on the market forecasts, estimated costs, production capacities, and engineering effort re-

quired, the economic package was rounded out by calculating the labor and burden rates, direct manpower requirements for production, purchase requirements, inventory value at any time, and manufacturing space requirements. A complete picture of what would be involved in the new program then could be made available to local and corporate management.

As a final step for justifying the automation expense of the proposed production, an economic evaluation of several alternative packaging schemes was authorized. These alternatives were in some cases purely hypothetical while others were based on schemes currently being used in other equipment. To make a comparison of the alternative to the proposed plan required that the alternative

ESTABLISHING MACHINE COST LIMITS

ECONOMICS of the automated equipment for the Standard Modular System were resolved by working up formulas and comparing the cost of automated equipment to semiautomatic equipment. The basic formula used was

$$T_c = P_c + M_c + R_c \quad \ldots\ldots (1)$$

where T_c is the total cost per insertion, P_c is the preparation cost of the component, M_c is the machine cost per insertion, and R_c is the labor cost per insertion.

The factor M_c or machine cost per insertion was determined by the following formula:

$$M_c = \frac{CT}{3600\,L} \quad \ldots\ldots (2)$$

where C is the estimated machine cost, T is the machine cycle or insertion time in seconds, and L is the estimated life of the equipment in hours.

The factor R_c or labor cost per insertion was determined by the following formula:

$$R_c = \frac{RT}{3600\,E} \quad \ldots\ldots (3)$$

where R is the labor and burden rate in dollars and E is the utilization factor expressed as a decimal.

Substituting Equations 2 and 3 in Equation 1 gives the following relationship:

$$T_c = P_c + \frac{CT}{3600\,L} + \frac{RT}{3600\,E} \quad \ldots\ldots (4)$$

$$= P_c + \frac{T}{3600}\left[\frac{C}{L} + \frac{R}{E}\right] \quad \ldots\ldots (5)$$

In order to compare the cost of an automated installation against the cost of a semiautomatic installation, a hypothetical semiautomatic operation was created assuming a machine costing $3000 with an estimated life of roughly 2 years or 4000 hours, a machine cycle or insertion time of 3 seconds, a 0.70 utilization factor, and a labor and burden rate of $10 per hour. These values, inserted in Equation 5, lead to:

$$T_c = P_c + \frac{3}{3600}\left[\frac{3000}{4000} + \frac{10}{0.70}\right] \quad \ldots\ldots (6)$$

$$= P_c + \$0.0126$$

Since the cost of component preparation is minor or can be performed by the operator during the machine cycle, P_c can be disregarded, and the total cost per insertion for the hypothetical semiautomatic equipment becomes $0.0126.

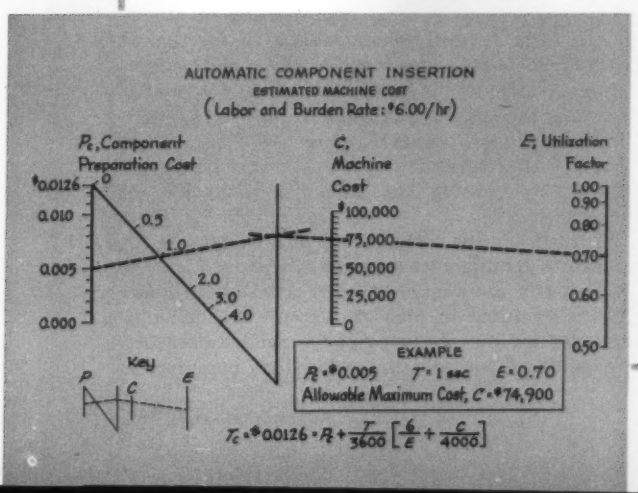
The next step in the economic analysis was to prepare three nomographs on the basis of labor and burden rates, R, of $6, $10, and $12 per hour for the automated equipment. By using a total cost per insertion of $0.0126, which was calculated for the semiautomatic equipment, the maximum investment that can be justified for an automated machine which will not exceed the insertion cost of the semiautomatic machine can be computed. The following three formulas were used for the nomographs for the various labor and burden rates:

$$T_c = \$0.0126 = P_c + \frac{T}{3600}\left[\frac{6}{E} + \frac{C}{4000}\right] \quad \ldots\ldots (7)$$

$$T_c = \$0.0126 = P_c + \frac{T}{3600}\left[\frac{10}{E} + \frac{C}{4000}\right] \quad \ldots\ldots (8)$$

$$T_c = \$0.0126 = P_c + \frac{T}{3600}\left[\frac{12}{E} + \frac{C}{4000}\right] \quad \ldots\ldots (9)$$

In Equations 7, 8, and 9 which are used to evaluate the automated equipment, the component preparation cost, P_c, cannot be dropped since it may be a sizable amount and labor charged to the operation does not include this cost. By substituting various values in these three equations, a set of three nomographs was derived similar to the one illustrated for a $6 labor and burden rate. By knowing the component preparation cost, cycle time, and utilization factor, the maximum permissible cost for an automated machine can be computed from the nomographs. This cost will not exceed the cost of the hypothetical semiautomatic machine doing the same insertion job. The life expectancy of each piece of automated equipment subjected to analysis by these nomographs is assumed to be limited to 4000 hours. This type of analysis may also be used in determining the proper design, cycle time, and efficiency of other types of automated systems.



be costed with as much care as the original program. This all takes time and money, but is well worth the peace of mind that results.

A final item that can also be included to form the total story on the economic justification of the production is to determine the cost for an entire failure of the proposed automation program. This item is certainly important in the establishment of any financial contingency at a corporate level in the event of such a catastrophe.

This completes a general description of the financial package required to justify the automation of the Standard Modular System production. It represents the approach taken by Manufacturing Engineering to sell this program, or any other such program to management. However, many other considerations are necessary to complete the package. These include product considerations, equipment selection and production planning, and operational economics.

Product Considerations

Product consideration amounts to standardization of the hardware to be produced. Within IBM, designing equipment hardware and circuitry on a corporate basis is indeed a difficult situation because of the very nature of the field in which the corporation operates, and the many types of equipment produced. Naturally, not everyone in product development engineering finds standardized hardware to his liking. However, with manufacturing engineering performing the preliminary design of the hardware to fit its automation equipment and with the economic justification completed, the ability to enter immediate production is a strong case for development engineering to accept the component designs.

It should be pointed out that standardization cannot be achieved without sacrificing something from the technical point of view. One example of this is that a standardized hole pattern for printed wiring boards does not lend itself to some applications, and often limits the component usage on that particular board. The cost of tooling and the projected usage for a new component hole configuration soon determine the life of an innovation such as this.

To arrive at realistic tooling costs, it is important that some idea be formulated of how much to spend on a piece of equipment relative to some known standard. This information then limits the tool engineer to the maximum amount of money he can spend for the amount of work the machine will perform. By proper arrangement of data, the maximum cost of equipment under consideration can be made to reflect a change of one, or a combination of more than one, machine operating specifications. This can be done by deriving formulas which will compare the proposed automated equipment to manual or semiautomatic methods now being used. Other aids such as nomographs can be prepared when many variables must be weighed against each other to reach the most desirable solution.

Consider Over-Automation

During the equipment selection and design phase, consideration should be given to providing for "over-automation" as a means of increasing production and reducing manpower. With over-automation, more equipment is made available than is necessary to meet daily production. Therefore, an entire line may be idle for certain periods after the production requirements have been met. This situation is favorable if there is a remote possibility that production may be increased in the near future. However, the ultimate cost of product must be weighed against costs of the additional equipment. This possibility existed during the study of an automated printed circuit manufacturing facility. After analysis, additional costs for over-automating this operation did not contribute a sufficiently significant cost reduction to the individual parts to gamble on the possibility of ever using the facility to full capacity.

Tied in with the selection of the proper equipment to perform the automated assembly is the manufacturing planning scheme which will enable inventories of finished assemblies to be kept at a low level. With a programmed assembly line, quick changeover time and complete flexibility of production are inherent. Thus, a stock of finished assemblies need not be maintained if the physical location of the automated production line is near the area where assemblies are required.

Operation Economics

The final phase to be considered could be termed "operational economics" and includes maintenance costs as one of its most important elements. For ordinary types of tools such as dies, etc., the standard formula is to allow 30 per cent of the total cost of the tool for maintenance the first year, 30 per cent the second, 20 per cent the third, and 10 per cent during the fourth and fifth years. Maintenance expense as defined here consists of alteration for engineering changes, alteration for manufacturing changes, and repair and replacement. Maintenance planning for the automated component insertion equipment is not quite so clean as the 30-30-20-10-10 split. Funds here must be requested on the basis of information received from the design engineers concerning the reliability objectives of their equipment.

With all of this effort being devoted to the solution of a manufacturing problem, engineering costs are high and must be distributed across the number of units produced in such an amount that the ultimate cost for the product can be stabilized as soon as possible. This does not mean that manufactur-

ing engineering, product engineering, and research expense amortization should be accelerated to the point that cost of components produced by automation is made prohibitive to engineering development programs. High packaging development costs have hampered many machine development programs.

The economics of an automation problem such as this are involved and subject to frequent revisions, but the approach taken by IBM to formulate this portion of the program has been proved quite realistic up to the point of present activity. As a result, procedures have been developed which will assist engineering and manufacturing personnel to better justify their plans in both the technical and economic areas of consideration.

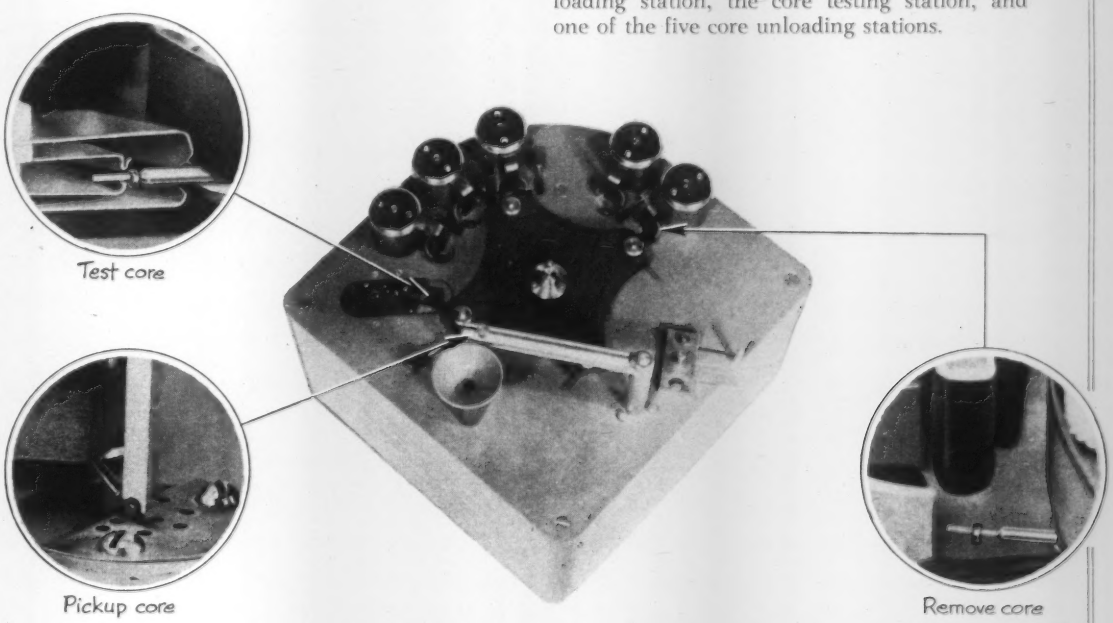
miniature line tests ferrite cores

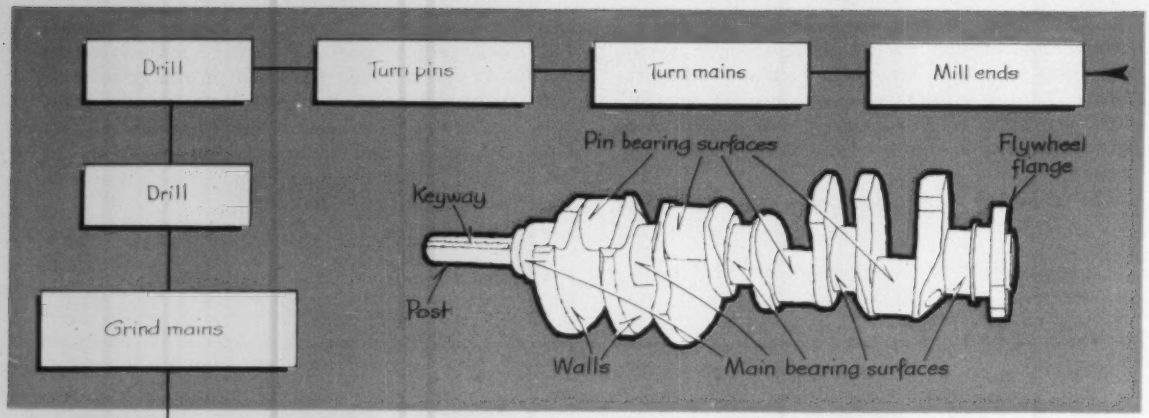
AUTOMATIC handler for orienting, testing, and classifying 0.080 inch diameter ferrite memory cores has been developed by Rese Engineering Inc. The miniature testing line is mounted on a 12 inch square base and is capable of handling up to 3600 cores per hour.

The tiny cores are loaded into a reservoir inside the base through a small funnel on top. As the reservoir vibrates, the cores are fed past a magnetic field which lines the cores up into tangential links. The line of cores is then guided to an escape flue in the base where one core at a time positions itself against a metallic shoe. In this position, the core is picked up by one of four test pins on a rotary plate and is carried between two sets of contacts at a testing station. Programmed pulses (supplied by an external source) are applied to the core through one set of contacts, and the second set of contacts picks up the induced voltage output from the core.

The results of this test are examined by an operator or by an automatic decision making circuit, either of which energizes a pickoff magnet at one of five sorting stations. The test pin is then indexed past the sorting stations until the core is magnetically removed at the proper station. The pickoff magnet is then deenergized, and the core drops into a funnel leading to the station reservoir located in the base of the unit.

For laboratory analysis of moderate quantities of cores, provision has been made for holding a core in the test contacts for an indefinite length of time to observe its voltage response. The grading method allows the tested cores to be deposited in one of five grade reservoirs according to the tested characteristics. Cores may be tested for peaking time, switching time, value of "zero" response, and/or value of "one" response. The accompanying illustration shows the testing unit and enlarged views of the core loading station, the core testing station, and one of the five core unloading stations.





Grind first pin

Grind second pin

Grind third pin

Grind fourth pin

Wash

Turn walls

Turn post

Mill keyway

Deburr

Balance

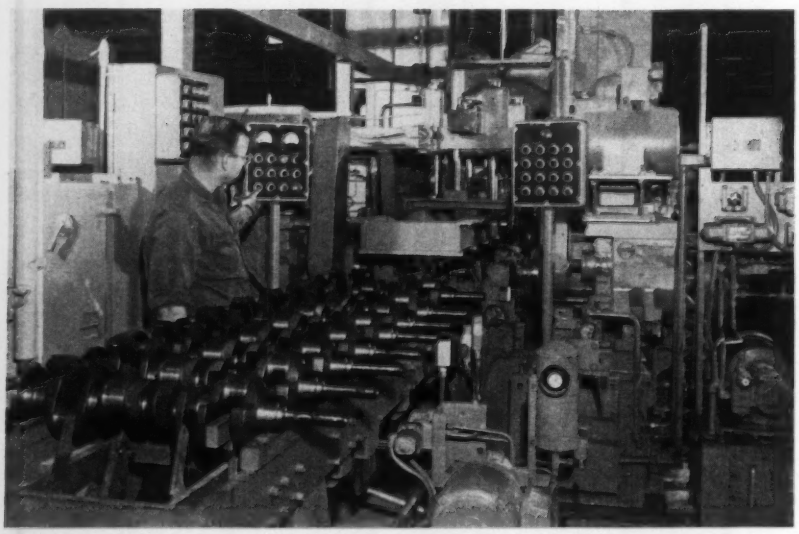
Lap

Flush and brush → Inspect → Wash →

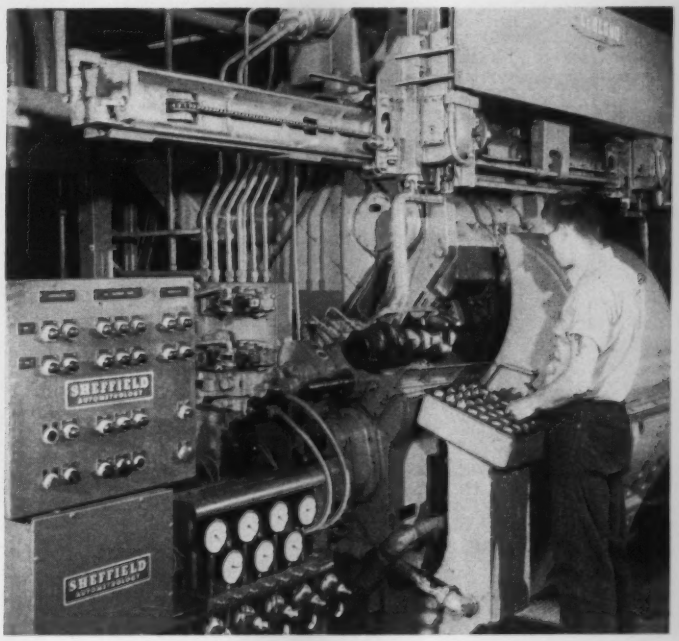
1 Engine production facility of the Ford Motor Co. at Lima, Ohio, includes highly automated crankshaft machining lines to perform the operations noted. The 80-pound crankshafts are moved through a line 588 feet long at a rate of about 80 units per hour.

AUTOMATION TODAY

HIGHLIGHT IN AUTOMATED PLANT FINISHING



2 Castings are received from the foundry on pallets and transferred, one at a time, by hoist to a walking-beam type transfer device. First operations mill both ends of the part to obtain proper length.



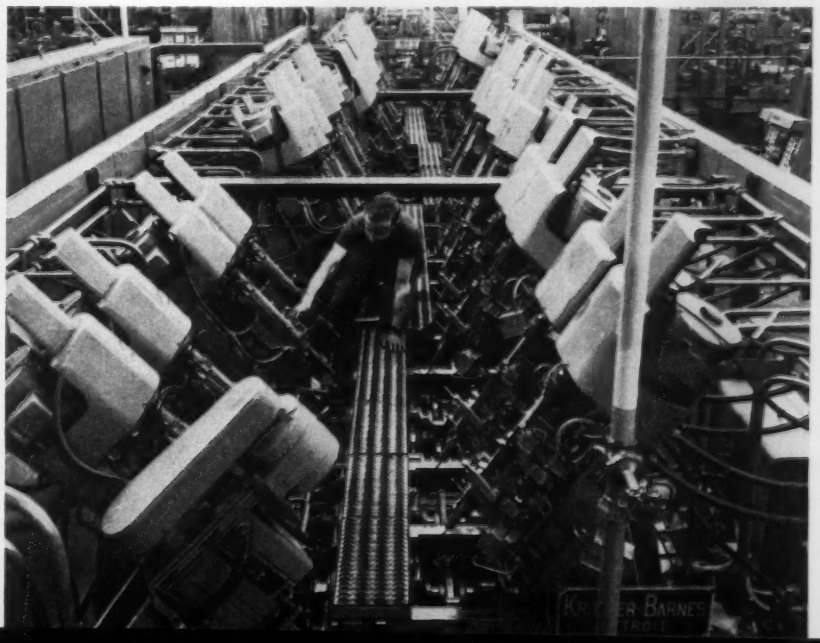
3

To balance machine production rates, the flow of crankshafts is split for some operations so that a specific crankshaft may pass through one of a bank of machines. Automatic handling devices perform the flow dividing function. This is one of the automatic lathes used to turn bearing surfaces on the workpiece. The overhead handling device loads the work into turning position and, after machining, deposits the machined part on a gaging fixture.

CRANKSHAFTS FOR ASSEMBLY

AN ACKNOWLEDGED leader in automation of metalworking operations, Ford Motor Co. has developed many extensive facilities for production of engines for its products in the last few years. Since World War II Ford has built two engine plants in Cleveland, renovated the Dearborn, Mich., engine plant, and now has in operation a new engine plant in Lima, Ohio. The Lima plant is the latest addition to the engine production family and represents experience gained from the earlier plants. It includes many highly automated lines, notable among which are lines to machine crankshafts.

Three crankshaft lines have been installed in the plant. They are long, simplified lines through which the parts flow evenly and smoothly from as-received



4

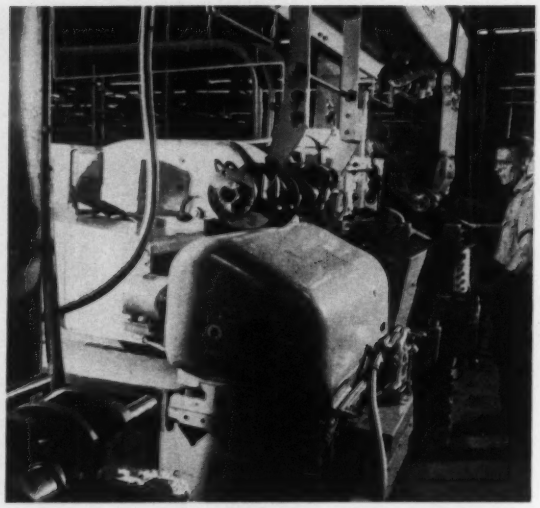
This 52-foot transfer machine is an integrated part of the 588-foot line. In this machine all the oil passages are drilled in the crankshaft.

castings to finished crankshafts ready for assembly. Inspection stations provide in-process checks that are an integral part of each line. These inspection stations are strategically placed after all critical machining operations so that any operation that drifts off specification can be spotted before many additional operations are performed on a workpiece.

Crankshafts are moved between machines by hydraulically actuated, walking-beam type mechanisms. The parts are picked up, indexed forward one station, and put down. Marring of finished surfaces is thus kept to a minimum, and the amount of re-orientation of the part required at successive stations is reduced.

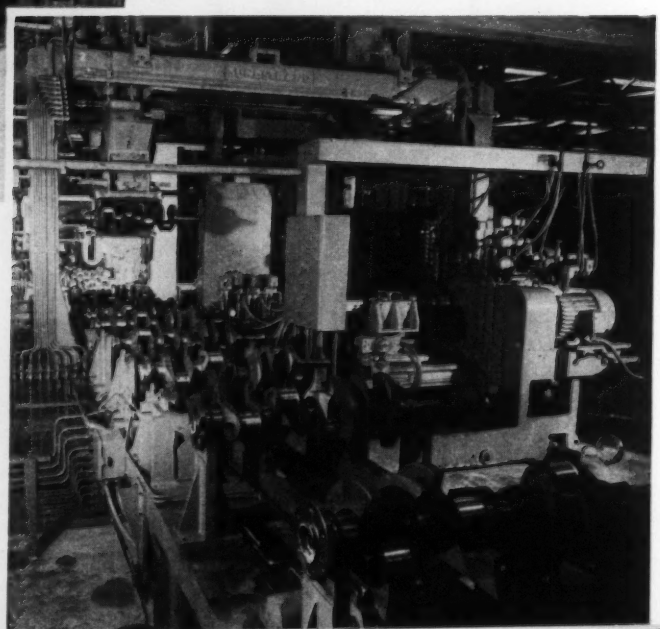
Machines in the automated lines are provided with automatic lubrication and chip removal systems so that production need not be interrupted for these supporting operations. Since the fatiguing functions of loading and unloading individual machines are also performed automatically, the operators can devote their full attention to supervision of the basic operation being performed. They are relieved of the auxiliary functions which normally divert attention from the basic operation.

Ford people feel that the crankshaft lines mark an outstanding development in production facilities. The accompanying photographs indicate a concrete basis for that belief.

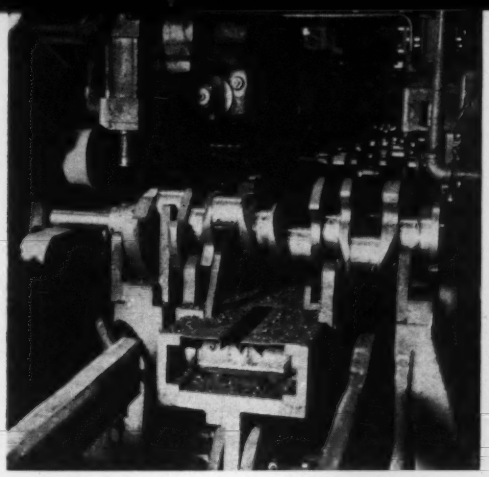


5 Workpieces are automatically conveyed to this grinder, which also has its own automatic loading and unloading device. Main bearing surfaces are simultaneously ground on this unit.

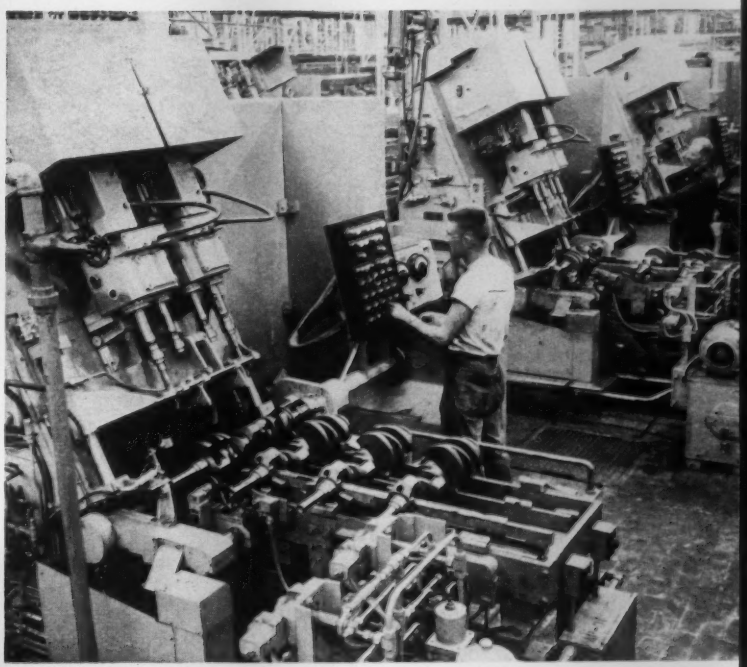
6 Each of the four pin bearing surfaces on a crankshaft is individually ground. The bank of four machines shown is one of two such series of machines. A crankshaft must pass through all four machines in a series. So that the two series of machines can face on a common aisle, with the machines in both series being the same, an automatic handling device turns end-for-end the crankshafts that pass down the second line. Right and lefthand machines are not required, though the loading and unloading devices must be reversed.



7 After a washing operation, the crankshafts are indexed through a series of machines that turn the walls of the throws in the vicinity of the bearings, turn the shaft extension known as the post, and mill the keyway that locates the timing gear on the post.

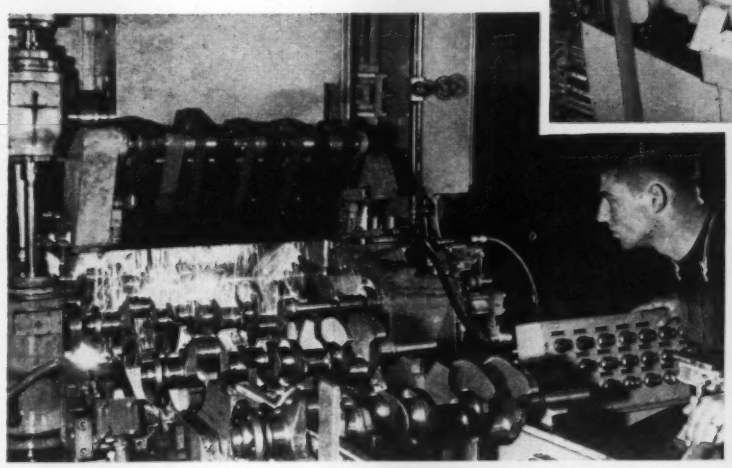


8 Burrs are automatically removed from the machined crankshafts in this unit. The parts are then ready for balancing in one of the machines in the bank of automatic balancing machines.

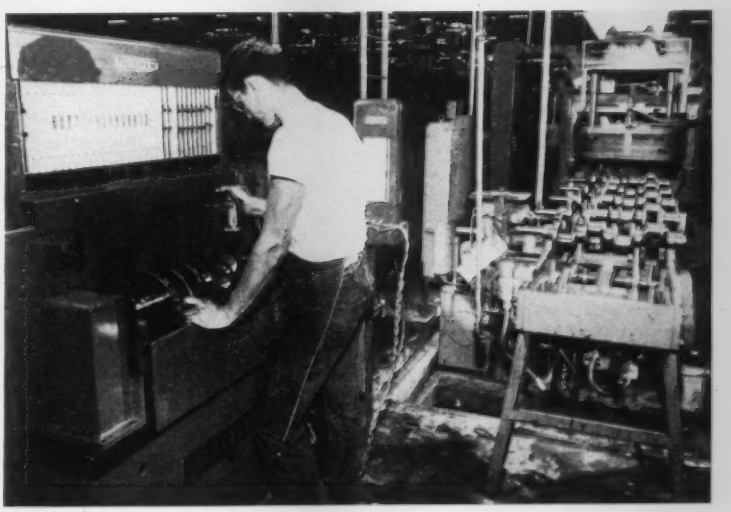


9 Overhead hoists are used to transfer parts to individual balancing machines. Each machine automatically determines the amount and location of corrections required to dynamically balance the crankshaft, makes the corrections by drilling, and rechecks to ensure that proper balance is obtained.*

*For details of a similar balancing installation, see W. M. Gruber—"In-Line Production Balancing," AUTOMATION, Vol. 5, No. 2, Feb. 1958, p. 80.



10 Main and pin bearing surfaces undergo a final finishing operation in this machine. The crankshaft is then given a cleaning operation and passed to inspection.



11 Thirty-two critical dimensions on the crankshaft are gaged on this air-operated visual gage. The parts are rotated in the fixture while they are gaged. After the inspector has passed a crankshaft, it is given a final washing and is ready for the engine assembly line.

DATA HANDLER MONITORS POWER PLANT VARIABLES

AUTOMATIC scanning and logging of operating data, with provision for signaling and locating off-limit conditions, are effected at the 210,000 kw Sterlington Steam Station of Louisiana Power & Light Co. Heart of the system is a data handling installation, *Fig.* 1, developed by Daystrom Systems Div., Daystrom Inc., for Ebasco Services Inc., designers of the new plant.

The data handling system is composed of four major elements: 1. An input section where signals from transducers are terminated and selected. 2. A digital section where the analog signals from the transducers are converted to digital values after selection by a control matrix register. 3. A computer section that furnishes the operational control of the system and performs mathematical functions such as scale factoring, linearizing, integrating, and comparison with limits. 4. An output section where final logging, printing, and trouble annunciation are performed.

Operating primarily in a scanning mode, the data handling system sequentially monitors up to 250 temperatures at a rate of five per second. Temperatures of bearings, transformers, boilers, and steam are typical variables monitored. Each temperature signal, generated by a thermocouple, is measured and compared with an alarm set point signal stored in a computer memory. If a thermocouple signal indicates an abnormal temperature, a trouble location annunciator sounds, and a lamp in a window on the annunciator panel is flashed to identify the major equipment affected. An alarm printer is also activated and records the defective reading, the location of the thermocouple in the plant, and the time.

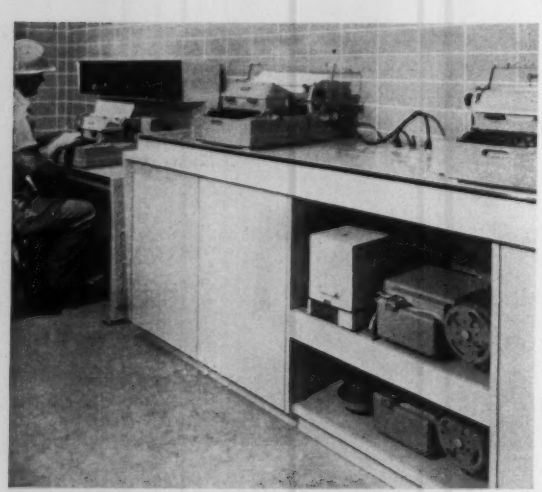


Fig. 1—Control center for power plant data handling system contains computer programming console, left, and output devices for punched tape and typewriter recording of data, right. System sequentially scans up to 250 temperatures throughout the plant and warns of abnormal conditions. It also periodically measures and logs these temperatures and the values of 100 other variables—kw, fuel gravity, pressure, and flow—for accounting and troubleshooting purposes.

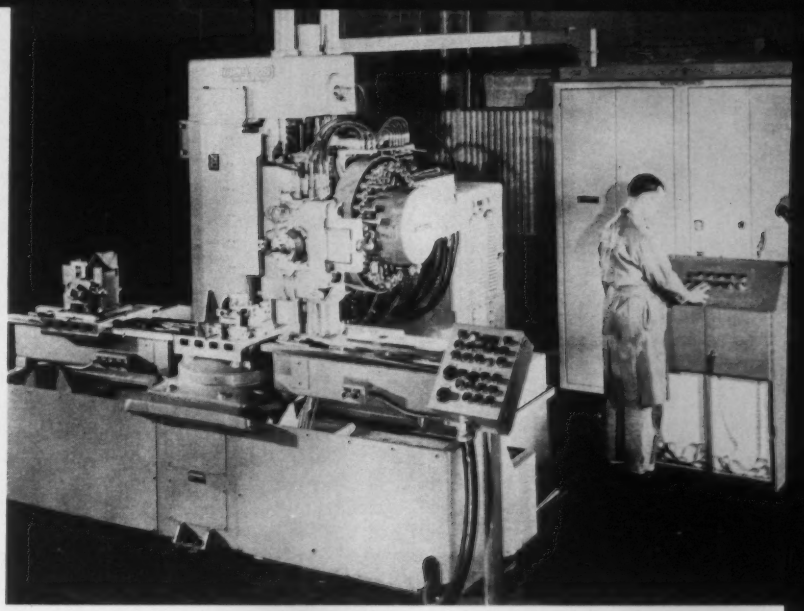
Open circuits in the themocouple lines are automatically detected during the scanning cycle and printed out as faults on the alarm printer. A *TC Open* window in the annunciator panel is illuminated to provide a visual indication that an open circuit has been detected. When a piece of equipment is out of service, its associated temperature points can be omitted from the scanning cycle.

In the logging mode, which occurs at scheduled time intervals or "on demand" by an operator, the scanning operation is temporarily interrupted, and readings of data are collected. These readings are processed by the computer and punched on paper tape at the rate of five points per second. In addition to temperatures, up to 100 plant readings, used for accounting and troubleshooting purposes, can be logged. Units measured include kw, vars, fuel gravities and heat contents, pressures, and flows.

Upon completion of tape punching, the system immediately returns to its scanning function. The perforated tape is routed through a tape reader and the logged data are then typed on preprinted log sheets at a rate of 1 point per second. The logging cycle includes a time of day and accuracy check besides the readings of logged variables. The speed at which the information from the computer can be punched is considerably faster than that of the tape reader and typewriters. This results in the data being recorded on the punched tape in less than a minute, while the typewriters continue operating for several minutes before logging is completed.

The computer receives its directions from a program which is prepared externally and "read" into and stored in the computer memory section. After a program has been stored, the system operates automatically, reading each program step from its memory without further external instructions. The program determines the sequence of commands for selecting inputs, mathematical operations to be applied to each signal, comparisons to branch to subroutines under specified conditions, output controls, and the insertion of fixed data such as limits, scaling factors, and calibration data.

Engineers of Louisiana Power & Light Co. regard the data handling system as a pilot installation which will provide operating experience with the type of equipment that will eventually be used to operate the entire power plant automatically. The projected system will provide programmed startup, operation, and shutdown of the power plant as well as continuous scanning and logging functions.



Tape controlled, combination machine tool developed by Kearney & Trecker Corp. is capable of completing milling, drilling, and boring operations during a single setup of workpiece. Controls for the machine were developed by General Electric Co.

NUMERICAL CONTROL OF PRODUCTION MACHINES

The most important development in production machinery in 50 years, numerical control is now off to a flying start. Systems in use number in the hundreds. What are the attributes of a good, practical system? What advantages are possible for small and variety-lot production?

By **WALLACE E. BRAINARD,** Chief Engineer, Servo Machine Tool Div., Kearney & Trecker Corp., Milwaukee, Wis.

TODAY, many people have a mental hurdle to overcome with respect to numerical control. The well-publicized numerically controlled profilers and skin mills, now doing an excellent job in the aircraft industry, require computers and mathematically trained programming people to provide tape information because of the nature of the complex workpieces. As a result, the casual observer associates computers and programming people with all forms of numerical control. While he admires and views with awe the achievements to date, he may have concluded that numerical control is not for his own commercial manufacturing operations.

This viewpoint, while understandable, is erroneous. The greatest field of application for numerical control—commercial manufacturing—will *not* require complicated tape making equipment nor the high degree of skill associated therewith. In the manufacture of machined components, numerical control is a simple, efficient tool that serves to extend the benefits of automatic manufacturing into the realms of low and medium volume output.

This article is based on a paper presented at the "Third Conference on Manufacturing Automation" cosponsored by AUTOMATION and Purdue University, March 1959.

Simple Make-Ready

Process planning is comparable to existing conventional methods. Tape making is an insignificant typewriter job. The additional skills required by any competent machine shop planner may be acquired in a week's time. Any typist can learn the new job in less than a day. Maintenance requires a week's training of existing personnel. There are no computers, no air conditioned rooms, no mathematicians. Emphatically, numerical control *is* for the average factory. The only change will be that of

adjustment to automatic production, short lead time, smaller lot sizes, and taking proper advantage thereof.

To illustrate, you are the PDQ Manufacturing Company. Included in your facilities are a few milling machines, drill presses, etc. Your market does not generate the production requirements for transfer lines or integrated automation equipment. You require a composite production consisting of from 10 to several thousand of each part per year.

You are the man who must get this computer complex out of your mind and take a square look at numerical control philosophy with regard to your own plant. You will, after due appraisement, probably start with one or two machines. You will select one of your better process planners and arrange for him to get a week's training. Later, he will instruct your typist. One of your maintenance men will also be given a week's training. With one or two machines, these men will not be busy all the time with the numerically controlled machines, so they can continue to do some of their normally assigned work.

During machine installation at your plant, your operators will receive on-the-job instruction. As far as installing the machine and getting ready to prepare tapes for operating it are concerned, no great turmoil will be experienced. However, indirect "people" functions will require some attention. The combination of administrative science and intuition, designed to control and compensate for the frailties and failures of human beings, will depreciate in importance. Guesstimating sales requirements will require less skill, since manufacturing lead time is diminished. The intricacies of scheduling and dispatching, machine loading, handling of operation job tickets, and so many of the complicated functions accompanying job shop techniques will be simplified, with an accompanying decrease in the importance of such jobs. People now firmly entrenched in the mysteries of these jobs will become uneasy and, perhaps, bewildered. The alert will welcome new opportunities—the vegetates will resist.

A numerically controlled machine has been defined as one that can automatically respond to instructions in the form of numbers. It might be argued that almost all machines satisfy this definition to some extent—as, for example, one that allows selection of a spindle speed by turning a dial to the appropriate number. Current usage of the term "numerical control" however implies the requirement that instruction numbers be provided in some convenient form recorded on tape or cards, to allow repetitive and automatic use.

MULTIOPERATIONS TAPE CONTROLLED

Recently the Servo Machine Tool Div., Kearney & Trecker Corp., has introduced the Milwaukee-Matic—a single unit, horizontal spindle, tape controlled production center capable of automatically performing milling, drilling, reaming, tapping, and boring operations in any sequence and on several sides of a workpiece during a single setup.

Three-axes motion in the hydraulically powered machine tool is provided by a laterally moving (X-axis) upright column; a vertically moving (Y-axis) saddle that is mounted on the column; and a transversely moving (Z-axis) machine spindle head supported by the saddle. A tool changing assembly and a large rotary tool magazine, the eye-catching features of the machine tool, are also supported by the saddle and located adjacent to the machine head.

Two types of worktables are available: The standard unit which indexes in 45 degree increments, and a special rotary table which can be positioned to an accuracy of ±20 seconds of arc. Anticipating that setups for new parts will be made while a part is being machined, the worktables have been designed to accept a movable pallet on which the workpiece is fixtured. Pallet shuttle equipment can be provided at both ends of the index table to permit automatic transfer of pallets on and off the index table.

The control equipment was developed specifically for this application by the Specialty Control Dept., General Electric Co. Data input from a standard, 1-inch wide, 8-channel punched tape controls positioning in three axes (rapid traverse at 200 ipm); selects spindle speeds (100-4000 rpm);

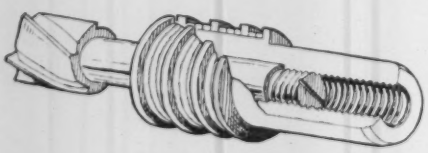
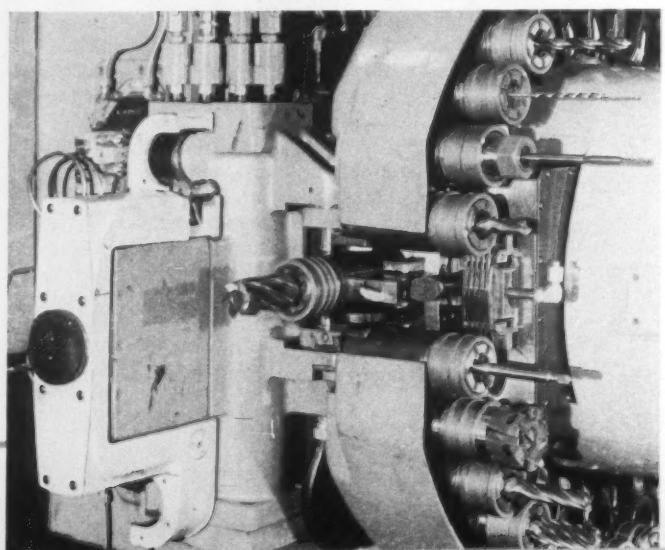


Fig. 1—Position of raised code rings in stacked arrangement of rings and spacers identifies individual tool holders. As shown in sketch, code stack fits over collet collar. Pattern of raised rings is sensed by a 10-fingered reading head as magazine rotates for search operation. When desired pattern is sensed, magazine is stopped. Reading head is located at point of transfer. This is shown in photograph where pocket containing tool holder has pivoted out prior to transfer operation, exposing the reading head sensing mechanisms.



▶ Types of Control

The nature of the machine control provided is, indeed, variable. Profilers and skin mills are controlled to generate curving contours at pre-established feed rates. Some positioning type machine tools are controlled in one or two axes but the operator selects feeds, speeds, and tools. Other machines may employ one, or several, of these functions in combination. Numerical control is destined to take over an increasing number of operator functions until the situation is achieved wherein an operator's job is merely one of the setup, workpiece handling, and general surveillance. Further refinements will provide off-line setup and workpiece handling—resulting in a continuous automatic manufacturing process.

The machining function, or functions, of a machine tool establish the nature and extent of control required. Does the machine merely drill holes, bore, or mill—or will it perform several machining operations? If it is a single purpose machine tool (the usual variety) several different such machines are required. Each must have the workpiece transported to it and have its operator clamp the workpiece in its special fixture to accomplish the manufacture of a finished workpiece.

Hence, the spectrum of numerical control seems to start with providing simple positioning control for one axis only, extending such control for two or more axes, and then adding control for feed rates and spindle speeds of single-function machines. Refinements can then carry the automatic concept to a point where the complete manufacturing process is automatically controlled. Further use of capabilities of numerical control will provide off-line setup and work loading.

▶ Economic and Technical Feasibility

The question naturally arises as to how far one should go with numerical control—simple positioning, all the way, or somewhere in between. Obviously, this is a matter of economic feasibility. If the acquisition of completely controlled machines can provide higher earnings than can some compromise solution, it is economically sound. If not, the cost of partial conversion should be evaluated in terms of the lowered cost of manufacturing and the proper stopping point should be determined.

Technical feasibility should not be overlooked. As machines and controls become more complex, reliability requirements increase exponentially. The

selects feed rates (1-99 ipm); selects worktable positions; selects and changes tools; turns coolant *On* and *Off*; shuttles pallet on and off machine; and starts and stops the machine. To eliminate nonproductive changeover time where different workpieces are being processed, the control system includes two tape readers.

A special feature of the control system enables the machine to perform approximate profiling operations. This capability enables a programmer to establish more efficient tool center paths, to profile for clearance dimensions, to dodge protrusions on the part or fixture, etc. Arcs with radii of 0.1 inch to 9.9 inches can be generated in increments of 0.1 inch. Angles are approximated to within ±1 degree of true slope. It is noteworthy that this working quality of profiling is obtainable without resorting to additional tape preparation equipment or special programming skills.

The underlying philosophy which sparked the design of this machine tool represents a fundamental break with typical machine tool practices. The design objective was to develop a single machine tool which could completely machine a part requiring typical milling, drilling, and boring operations. For a given part, complete machining might not be possible, but the advantages realized by using a versatile machine tool are directly proportional to the extent a part requiring multiple operations can be completely machined at a single setup. Principal advantages are to be found in increased machine utilization, reduced inventory, savings on tooling, and improvement in administrative considerations of machine shop operations.

Accepting the fact that servo systems and numerical controls (though hardly developed to the point where no problems occur in their use) are proved forms of actuation and control, development of a machine with the required versatility depended on the successful design of a tool storage and transfer capability.

The unique design provides for storage of 30 tools in a circular magazine. As previously mentioned, this magazine is mounted on the saddle. The magazine rotates about its center, in a plane of rotation defined by the Y-Z axis of the machine tool. With this orientation of a drum-type magazine, the general transfer problem involves: 1. Identifying a desired tool out of a possible 30 and moving the tool to a transfer point. 2. Changing the orientation of the desired tool by 90 degrees, since in the magazine the axis of the tool is parallel to the X-Y plane rather than perpendicular to that plane as it must be during use. 3. Positioning a transfer mechanism relative to the desired tool in the magazine and the machine tool spindle such that an existing tool in the spindle can be removed for storage and the desired tool placed in the spindle.

Standardized units of transfer are provided by straight-shanked tool holders, in which various size cutting tools up to 2-5/8 inches in diameter are accurately preset in accordance with programming instructions. In addition to specifying setup dimensions, the programmer also designates a coded identification for each tool holder. The identification is established by the position of code rings in a stacked arrangement of rings and spacers that fit over the collet collar of the tool holder, *Fig.* 1. Various position combinations involving up to 10 rings are used to identify the individual holders.

Given a command to transfer a certain tool, the magazine rotates and a 10-fingered reading head examines the coded ring stack on each holder as it passes the reading head. When the desired tool holder is sensed, the magazine stops. If the desired tool holder is not in the magazine, the magazine

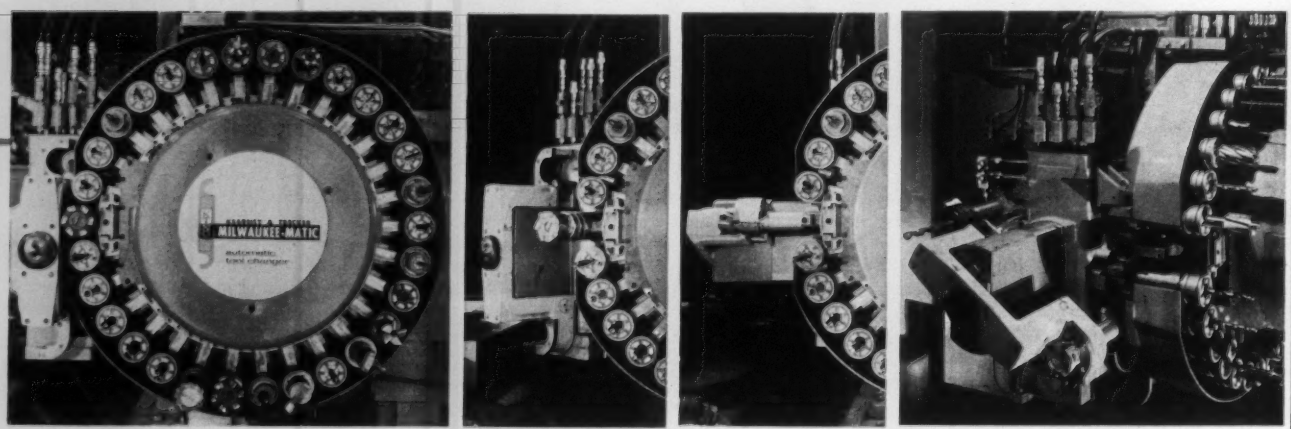
well-known relations between number of components and system failure rates, together with the higher dollar losses due to downtime as production rates increase, accounts for this. Solutions are not easy. For example, at Kearney & Trecker over a period of more than 3 years, five automatic numerically controlled machines were built and tested before adequate solutions to the problems of performance and reliability were attained. During this time, 35 semiautomatic numerically controlled machines were built, of which three were retained for our own use. It was only after this work had been accomplished that the knowledge necessary to design and build completely automatic machines with satisfactory performance and reliability was developed.

▶ Over-all Reliability

Let us define a factory as comprising those facilities necessary to manufacture completed workpieces, starting with raw material (be it plate or bar stock, a weldment, casting, or forging). Such a factory then includes the machines, material handling and storage equipment, building, and people to operate the machines, handle the material, and generate and use the associated paper work. If we are concerned with the over-all reliability of such a factory, we are then interested in the individual reliabilities of its different components. These reliabilities can be factored by the number of components in each group and the over-all figure compared with that for a numerically controlled factory of equivalent capacity.

Comparison of the two types of factories will show that the numerically controlled one has fewer machines, fewer people, less area, less material handling, fewer and simpler jigs and fixtures, and less paper work. The conclusion is inevitable then, that because of its lower population of similar components, the numerically controlled factory will be the more reliable—unless some of the newly introduced components have much higher individual failure rates than the components common to both factories.

We all know that people with pencils make more errors than do fewer people with adding machines. We also know that many operators with



(a) (b) (c) (d)

Fig. 2—Series of pictures illustrates actions of automatic tool changer. With the desired tool holder at point of transfer opposite reading head as shown in **(a)**, the transfer assembly and the magazine pocket containing the desired tool holder pivot out, **(b)**. Subsequently, the transfer arm of the transfer assembly rotates, grasps tool holders in both magazine and spindle after which the transfer assembly extends, withdrawing the tool holders for transfer, **(c)**. In **(d)**, the transfer arm is shown rotating, effecting the transfer of the desired tool holder to the spindle and, simultaneously, placing the prior tool holder in the magazine.

continues to rotate until the operator takes corrective action. The reading head is located at the point of transfer—thus the system provides for identification of the desired tool and positioning at a specified location.

At the transfer point the hinged magazine pocket containing the desired tool holder pivots out, orienting the axis of the tool parallel with the axis of the machine spindle. Simultaneously, a hinged transfer assembly swings out from its parked position, freeing a center-pivoted transfer arm to rotate. Each end of the transfer arm is provided with means to securely grip a tool holder.

In a transfer operation, *Fig.* 2, the transfer arm rotates from its parked position and simultaneously grips the desired tool holder in the magazine and the tool holder (if present) in the spindle. Moving transversely, the transfer assembly then withdraws both tool holders. Following a rotation of 180 degrees by the transfer arm, the transfer assembly retracts, seating the desired tool holder in the spindle and the prior tool holder in the vacated pocket of the magazine. The grip on both holders is relaxed; the transfer arm rotates

engine lathes scrap more parts than does one man with an automatic. Player pianos and Swiss music boxes make no sour notes. Undoubtedly, any move toward automatic manufacturing is one toward higher reliability because of the reduction of that family of components having the highest individual failure rates—people!

▶ Current Manufacturing Practice

Taking a critical look at the average production shop as we know it today, it is usually a large warehouse for "work in process"—a term that often means work that is stalled in the traffic jam at each machine center. The job is to remove, in some fashion, the unwanted metal and send what is left to the assembly department. Machines remove the metal. Hand filers in the de-burring department are actually the only ones who perform direct labor on the part.

Today, we observe people called "direct labor" at each machine. Actually, they are not performing direct labor—in fact, they usually attend the machine in a manner which prevents it from working a great deal of the time while they load and unload parts and dust off chips. The machine also waits while humans set it up for new jobs.

Since machines have been designed to be attended by people, the machines are not very flexible. Many different machines are usually required to remove all the metal—mills, drills, tappers, borers, etc. Generally, the part has to be lifted up and secured to a succession of these machines since they do not seem to be able to reach very much of the workpiece geometry at one attempt. It has not been feasible, either, to change tools, speeds, and points of measurement during the operation.

This usually means each machine must have an individual holding fixture. Some of these get complicated, since few machines have a means of measuring. So drill jigs, for example, have tailor-made measuring systems in the form of drill bushings and plates, through which it is hoped the operator will thrust the proper-sized tool after he has wrestled either the fixture or machine member into an approximate position. So we observe these people spending a portion of their time lifting or pushing material into position, while the machine waits. Then they push a button and wait for the machine to do its bit.

After the required quantity of parts is made (less than 50 in most shops), then occurs an interesting procedure known as "setup" (also incorrectly termed "direct labor"). This is a case of human labor made necessary by the inadequacies of the machine. During this time, the machine is of no earthly use. Setup consists of wrestling with jigs and fixtures, turning knobs and dials, and using improvised measuring devices in order to get everything ready for the next job. Some of the adjustments have to do with spindle speeds and feed rates. For a given cutting condition there is an optimum speed and feed range, which is often ignored. Without an incentive system, one works on the low side of the range, avoiding handling so many parts each day. This also rubs the life out of cutting tools. With an incentive system, one naturally works on the high side, which results in bigger pay checks and creates more jobs for fellow laborers in the tool grinding and broken tool repair room.

This type of manufacturing system has a definite consistency of performance. It is possible to predict, with good accuracy, that this system will remove too much metal; not enough; from the wrong place; or combinations thereof. This is about as far as a forecast can go, therefore, a method of masking the inherent unreliability of this system has been devised. We call it "Quality Control". It is used for the purpose of extending the time a machine must wait for people to get out of the way. We call this "first part inspection". A branch of this science called "finished part inspection" is for the purpose of creating some extra jobs for another group of people—"Production Control"—who are concerned with balancing inventories which become unbalanced by the quality control group who reject parts. It also creates jobs for additional setup men who are now able to make machines wait for the opportunity of making but one or two parts in order that inventories may be rebalanced. Some-

back to its parked position; and both transfer assembly and magazine pocket pivot back to complete a transfer cycle.

Automatically placing the initial tool in the spindle involves both the search (max. 0.07 minute) and the tool change cycle (0.15 minute). Subsequently, the search operation occurs during the machining operation and the tool change cycle becomes the most lengthily nonproductive time element in the machine's operation. To lessen the nonproductive time, advantage is taken of the high repetitive accuracy of the machine by sequentially programming for as many requirements of a given tool as is possible. For example, if a part design includes several holes of the same size requiring spot drilling, drilling, and tapping, each of the operations would be completely performed for the entire pattern before a tool change is specified. In this manner only three tool changes would be required, regardless of the number of holes.

With the successful application of numerical controls to machine tools over the past several years, it has been realized that the door has been opened to possible development of new forms of machine tools. As a graphic indication of progress toward the new-look in machine tools, it can be noted from the photographs of the Milwaukee-Matic that no provisions in the form of handwheels have been made for manual operation. As an indication of actual metal cutting time that manufacturers can expect from this type of machine, utilization in excess of 75 per cent of the time has been experienced instead of the normal 15-25 per cent for standard machines. Of studies made to date for possible application of the $140,000 Milwaukee-Matic, approximately 80 per cent indicated significant savings, enabling machine write-off times ranging from less than one to three years.

times one of the two parts is scrapped and everybody gives up.

The ills of this manufacturing system have long been recognized. Hundreds of thousands of stop watches have been worn out establishing the length of time it takes a man to do things that would not be required in a numerically controlled machine process. Micromotion study techniques have been adopted which point the way toward wasting time with the least physical effort. Bins, boxes, skids and all kinds of material handling and storing devices have been created in order to make it possible to substitute a 4-month manufacturing cycle for one of a few minutes or hours. Tons of drafting paper have been used to lay out factories for inefficient operations. Many "Principles of Production Control" have been instilled in the minds of people to allow the exact determination of unnecessary lead times, machine loading, machine center scheduling, the dispatching of related orders, and the control thereof. Naturally, these factory systems have a low order of reliability—consequently, the expediter and order chaser are needed.

As the technique of extremely long manufacturing cycles developed, money problems in respect to process inventory costs appeared. A crutch called "Standard Cost Accounting" came into the picture. It consists of converting the stop watch observations of useless labor into dollars of fluctuating value and applying these exactly calculated amounts to unknown quantities of semifinished merchandise lying about the factory.

Many will claim the foregoing sarcasm is unfair. In some respects we concur. An equivalent case might be presented against our pioneers for choosing the covered wagon in lieu of a first class train or airplane. However, the man who today would venture across the continent behind a team of oxen would be regarded as backward, indeed.

▶ Numerically Controlled Production

The acceptance of tape controlled machines by many industries has been phenomenal. The idea of extending the philosophy of numerical control to one of completely controlling a manufacturing process is so new that most people are unaware of its development and availability. As this knowledge spreads, the most progressive manufacturers will immediately put it to use. Others will take a little longer to make up their minds—and, of course, there will still be those who doggedly resist the resulting economic pressures until wiser judgments take over.

The preceding discussion was intended to answer questions such as: *What are the attributes of a good, practical factory?* A good, practical factory should perform all, or as much of the work automatically as may be economically justified. This implies adequate accuracy, reliability, size, speed, and power range of the equipment.

Economic justification requires a study of the workpiece family and production rate requirements.

Table 1—Advantages of Numerically Controlled Productive Equipment

- Reduced labor costs
- Reduced inspection costs
- Consistent machining accuracy
- Reduced tooling costs
- Low process inventory costs
- Less material handling and storage equipment
- Fewer machines required
- Less floor space
- Shorter lead times
- Greater flexibility of programming
- Ease of product design change
- New products can be introduced oftener

A flat piece requiring only drilling would necessitate a cost comparison between conventional methods, and perhaps a simple drilling machine with tape controlled positioning. A workpiece needful of boring accuracy, presently obtainable under temperature controlled conditions only, should not be placed on a manufacturing machine which might heat the work during milling and drilling operations unless the boring operations might be omitted and performed later in a temperature controlled room. The advantage of a tape controlled jig borer should, by all means, be explored. Economic study, to be realistic, requires a knowledge of all applicable methods. For example, workpieces requiring a multiplicity of milling, drilling, tapping, and boring operations can usually be completely finished on a tape controlled manufacturing machine more economically than by other methods.

What advantages are possible for small and variety-lot production? Short lead times, reduced labor costs, and flexibility of part design and programming are among the advantages of numerically controlled productive equipment, TABLE 1.

How about dollar savings expectancy? Hundreds of parts from a variety of diverse industries have been studied. Many parts have actually been run. Of these, about 20 per cent did not justify the use of numerical control. Of the balance, equipment pay-off periods ranged from less than a year for a few, to several years. The majority fell in the 1½ to 3-year bracket. This answer implies that one should not blindly embark upon the numerical control concept without analyzing its applicability to specific problems.

In conclusion, numerical control *does not* imply computers and highly specialized skills. It is economically sound and applicable in most metal cutting manufacture. In most cases, it should go all the way in order to provide a completely automatic manufacturing process. It is a method of manufacturing that will obsolete the concepts and machinery now employed in small and medium lot production.

TRUCKS INTEGRATE DRUM FILLING AND SHIPPING

OUTPUT ACHIEVED by a high production line is heavily dependent on the provisions for bringing materials to the line and taking away the product. One of the basic means used in accomplishing this handling function is the industrial truck. An industrial truck is found, more often than not, at both ends of the processing cycle. Such trucks move raw materials from delivering carriers to storage and to handling means associated with the processing equipment. After processing, the product is usually packaged in some manner and is moved to storage and shipping carriers by industrial trucks.

One of the production operations in which industrial trucks play an integral part, with some interesting side considerations, is at the Standard Oil of Ohio Refinery No. 2. In one area of this plant, oil products are piped from storage and production operations to a drum-filling line. Empty drums move on a conveyor into the automatic filling equipment, *Fig.* 1, where a scale installation controls the fill by weight. Top speed for filling 400-pound drums is about two per minute, but average filling rate is about one per minute. After being filled, the drums are closed and marked, and then they are moved past a simple arm arrangement that splits the single file of drums into two parallel lines, *Fig.* 2.

One of the industrial truck links in the system then takes over with a special gripping attachment that picks up four drums at a time and places them on pallets. This truck thus acts as a palletizing machine for the heavy drums, besides removing them from the conveyor.

A second industrial truck of different design, *Fig.* 3, then acts as a special carrier to move loaded pallets to a warehousing and distribution operation several thousand yards from the filling line. This straddle carrier, built by Ross Carrier Div., Clark Equipment Co., was fitted with special lifting skids so that it can be driven over a line of loaded pallets; pick up six of them; and deliver the load.

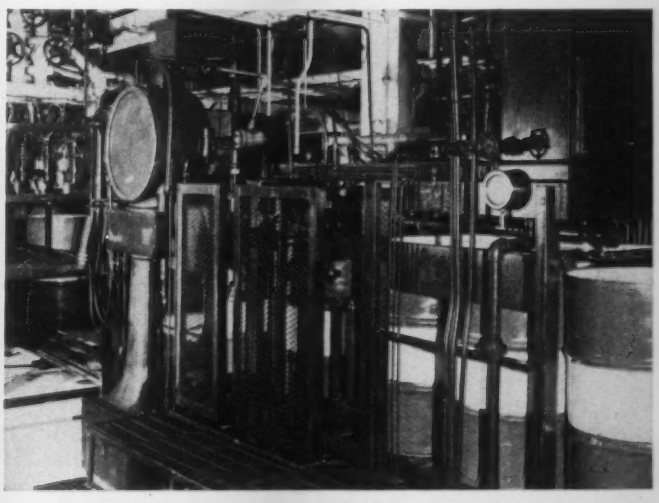
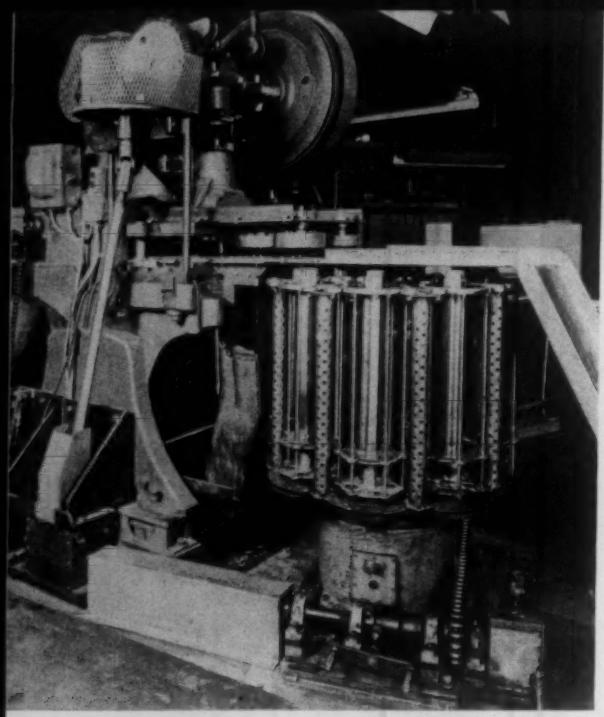


Fig. 1—Filling installation puts 400 pounds of oil into drums brought to it by roller conveyors.

Fig. 2—Filled drums are shunted into two parallel lines where an industrial truck with a special load clamp acts as a palletizing machine. It picks up four drums at a time and deposits them on pallets.

Fig. 3—Transportation of loaded pallets to another plant location is performed by straddle carrier type industrial truck. Six pallets, a load of 24 drums, are handled per trip.

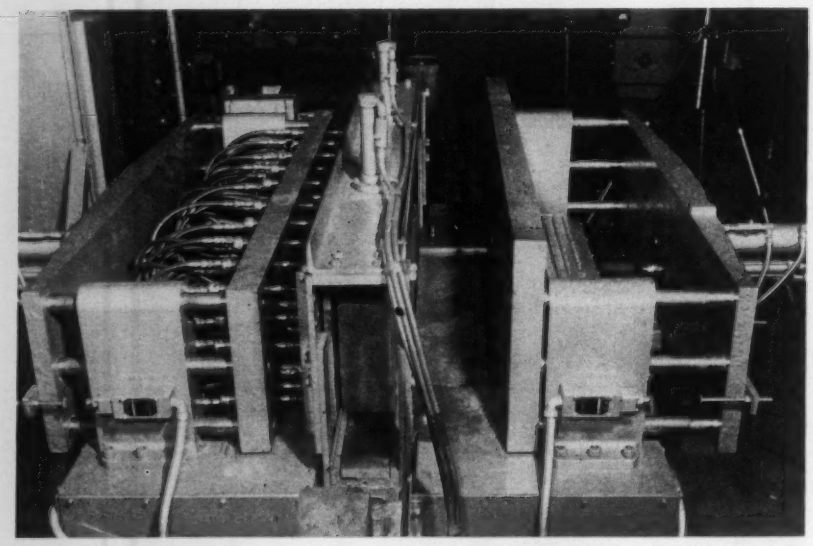


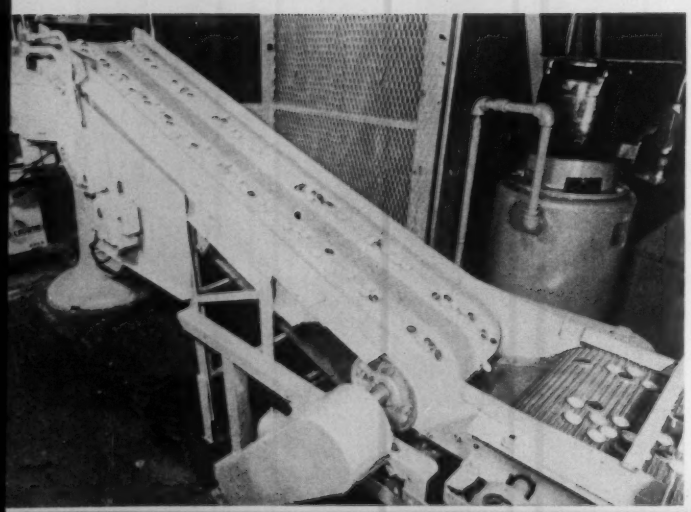
Punch Press Feeder

PRODUCTIVE capacity of a punch press that turns out oil filter laminations has been increased by 50 per cent with the addition of cam indexed feed rolls. At the Hilliard Corp. plant, cellulose felt material is fed into the press by the feed rolls, and parts are blanked on the press downstroke. Spring actuated pads push the part back into the strip during the press upstroke. The strip advances the blanked part to a dieing operation, after which the part is ejected. To handle output of the press, an indexing table has been equipped with eight stacking magazines which, in turn, rotate beneath an ejection point. The cam indexing drive and the precision indexing table are products of the Ferguson Machine Corp. of Indiana.

Multidrill Machine

DRILLING machine produced by special machines section of Gardner-Denver Co. is designed to drill hundreds of holes in carbon blocks. Used in atomic energy work, a block in the center fixture can be indexed laterally and vertically before the array of 99 drills mounted on a plate, at left, which is capable of transverse motion. In a 30 second period, the machine performs a series of 5 drilling and indexing cycles, placing over 400 holes in the block with the 99 drills. Larger mounting plate at right, shown without an array of drills, is capable of same type of transverse motion as the left mounting plate.





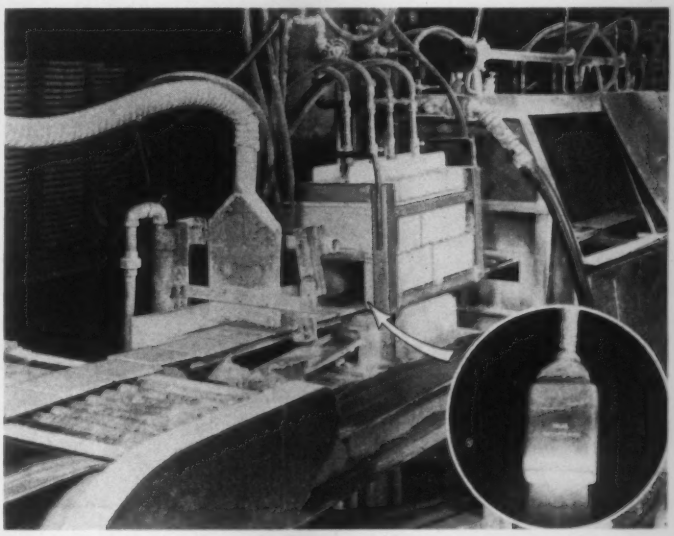
Magnetic Parts Handler

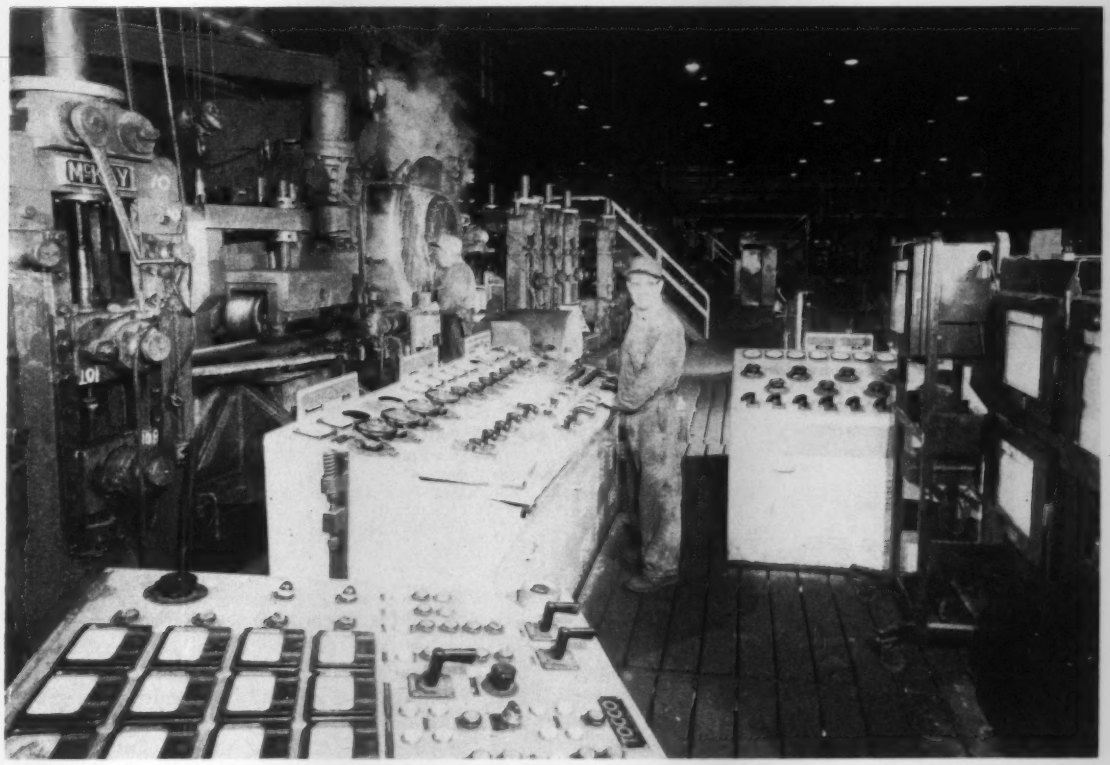
PRIOR to automatic counting and packaging operation, metal caps are transferred from a mesh conveyor to a belt conveyor. Pulley at lower end of belt conveyor is a permanent magnetic type, built by Eriez Mfg. Co., containing two magnetic elements. The magnets are so arranged as to align the caps in two rows as they travel up the belt conveyor. The transfer from the mesh conveyor to the belt conveyor occurs across a small gap through which material not affected by a magnet can drop.

in action

Tile Glazing

SMALL brick-lined hood containing four gas burner heads preheats tile on a continuous production basis at a rate of 108 tiles per minute. Superheat burners of the type shown in the inset are manufactured by Selas Corp. of America, and are capable of releasing heat at rates as high as 40 million Btu/cu ft/hr. In the illustrated application at Robertson Mfg. Co., the moving line of green ware tile is subjected to a blast of hot gases at approximately 3000F and a velocity of 2500 ft/sec, preheating each tile prior to its passing through a glaze-spray booth. A similar furnace on outlet side of the spray booth contains two burner heads and dries the glaze to the point that tiles can be immediately handled and stacked into racks.





Welded Pipe

ELECTRICWELD line pipe up to 12¾ inch OD is produced under close control in the Aliquippa plant of Jones & Laughlin Steel Corp. Welding current is automatically regulated with changes in mill speed to maintain welding temperature. Continuous measurement of welding pressure and electrode pressure guides the operator in achieving optimum values. Illustrated is only part of line that receives coils of hot rolled skelp, prepares edges for welding, progressively bends the skelp into a cylinder, resistance welds the edges of the cylinder, trims flash, and cuts the moving pipe to specified lengths. Subsequently pipe lengths are subjected to quality tests, including a hydrostatic pressure surge test.

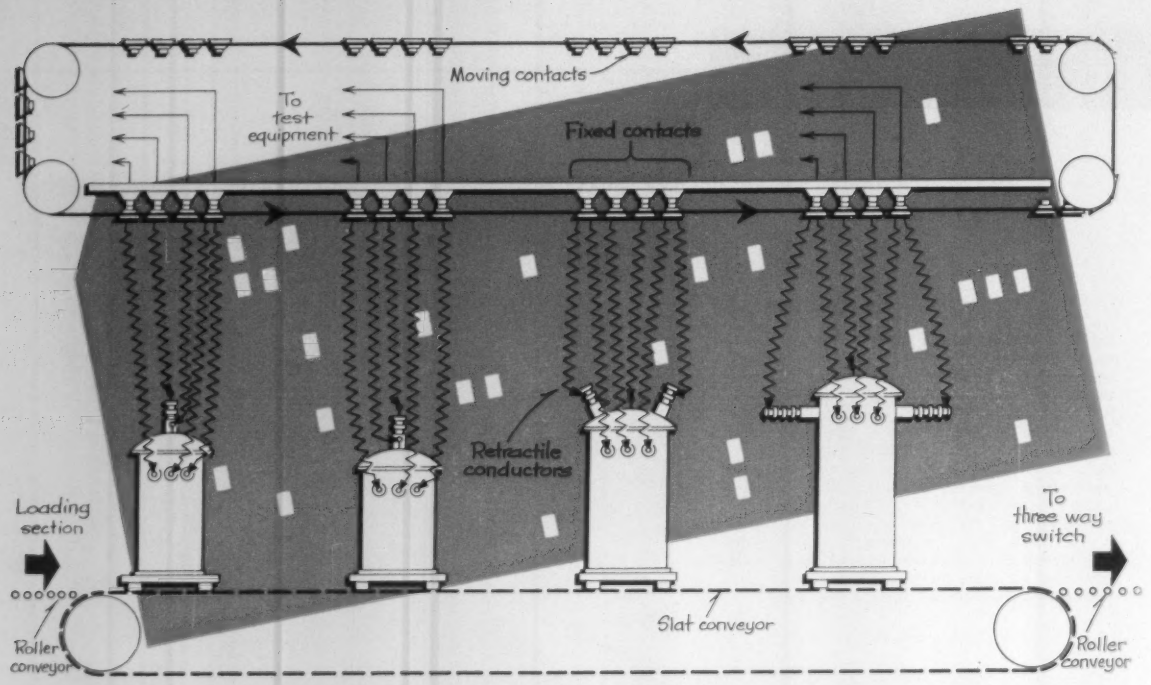


Fig. 1—Schematic drawing indicates conveyor arrangement developed to automatically test variety of distribution transformer styles and sizes. Transformers index through nine test stations. Synchronized with main conveyor, overhead lead conveyor indexes moving contacts that mate with fixed contacts, providing connection to test equipment located alongside main conveyor. The conveyors were supplied by the Logan Co.

UNIQUE CARD READER SIMPLIFIES

PROGRAMMED TRANSFORMER TESTING

By J. J. LAHM and G. S. PAIL
Supvr. Equip. Development Equip. Development Engr.
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POLE TYPE distribution transformers can be seen almost anywhere that commercial electric power is used. Perched high on utility poles, they are generally taken for granted by the power consuming public. Since these transformers are basically static devices, their life is measured in decades rather than in years. Operational failures are expensive in terms of both customer satisfaction and repair dollars. These facts make it particularly important that distribution transformers are thoroughly and accurately tested during manufacturing.

Confronted with this need for thoroughness and accuracy, and a discernible trend toward increasing the number and complexity of commercial tests, the Distribution Transformer Dept., Transformer Div., Westinghouse Electric Corp. initiated a project for automatic testing of distribution transformers. The project resulted in a unique automatic test facility—and development of equipment and concepts which can be applied effectively to other operations.

The project goal was to design and build a facility which would perform and record all of the commercial tests required for pole mounted distribution

transformers. The tests were to be programmed automatically from punched cards, one card for each transformer. Test results were to be automatically recorded on the same card which programmed the test. Since the test facility was to handle a majority of the transformers produced, reliability of operation was of the utmost importance. Because the required test equipment was so closely related to the product, it was felt advisable to do most of the development engineering internally. The services of both materials handling and data handling specialists were employed, however.

Material Handling

The main conveyor of the system is a 52-foot long slat bed unit which transports the transformers through the test facility. It provides stations for 13 transformers: Two stations for making connections, nine testing stations, and two stations for disconnecting. It is capable of handling units up to 60 inches high and weighing up to 1500 pounds. Although an overhead monorail conveyor system offered many advantages, it would have been incompatible with existing conveyors in the production area. The available floor area precluded the use of a merry-go-round type arrangement which would have made it possible for one operator to both connect and disconnect the units being tested.

Above, and synchronized with, the main conveyor is an overhead conveyor that carries the electrical conductors, or leads, which connect the transformers under test to the test equipment, *Fig.* 1. Movable slats on this lead conveyor are equipped with contacts which mate with the contacts of corresponding slats which are fixed to the conveyor frame. Since the movable slats are connected to the transformer under test by means of retractile cords, the connections to the test equipment are automatically commutated by conveyor indexing.

Advantages of programmed, automatic testing of transformers include greater worker safety, increased accuracy at lower cost, and improved recording of test results. By-products of the engineering development necessary to achieve these benefits include concepts, circuit designs, and equipment that can be applied to other operations.

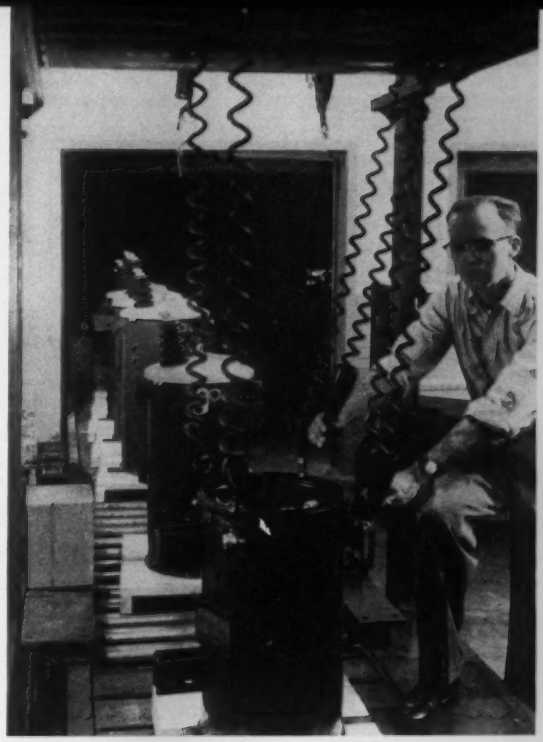


Fig. 2—Loading section of powered roller conveyor precedes main slat conveyor. Photoelectric control mechanism spaces transformers such that when the transformers are loaded on the slat conveyor they are beneath retractile cords attached to overhead lead conveyor. The retractile conductors are attached to the transformer by an operator.

When actuated, both conveyors index 4 feet and then stop. Accurate indexing of the lead conveyor is required so that the movable contacts will make connection with the stationary contacts connected to the test equipment. The indexing motion of the main conveyor is smooth so that the oil in the transformers does not spill. The drive motor picks up the load by means of a magnetic clutch. Braking is applied in two stages both of which are initiated by limit switches actuated by conveyor travel. Conveyor motion is first slowed by regenerative braking and then stopped by a shoe type brake.

In order to simplify the loading of the main conveyor, a special loading section which automatically spaces the transformers on 4-foot centers was provided. This short section of live roll conveyor is driven through one of two overrunning clutches. It is first driven by a separate gearmotor and then by the main conveyor. The gearmotor clutching arrangement turns the rollers until a transformer, which was pushed onto the loading section by the operator, interrupts a light beam. A photoelectric relay then stops the gearmotor and a pneumatically-operated barrier raises to prevent other transformers from entering the loading section. The transformer is now positioned for proper loading onto the main conveyor. When the main conveyor indexes it drives the live rollers through a chain belt

Fig. 3—Master control console for test facility houses all general controls and alarm indicators. The monitor panel on the console enables operator to quickly locate any malfunction which might occur in the test equipment.

and the second clutch. The transformer moves onto the main conveyor in position to receive test leads, *Fig.* 2, and the barrier is lowered so that the next unit can be positioned. This arrangement simplifies an operation that would otherwise be quite difficult, and possibly dangerous.

▶ Master Control

The term "master control" refers to all general controls of the facility, other than the data handling system and the test stations proper. It includes the master control console, *Fig.* 3, associated relays, and the intercabinet control wiring. All general controls and alarm indicators are housed in the master control console. Once the equipment has been placed in operation from this console, normal operation can be maintained from two small remote control stations. These remote stations are located at either end of the main conveyor.

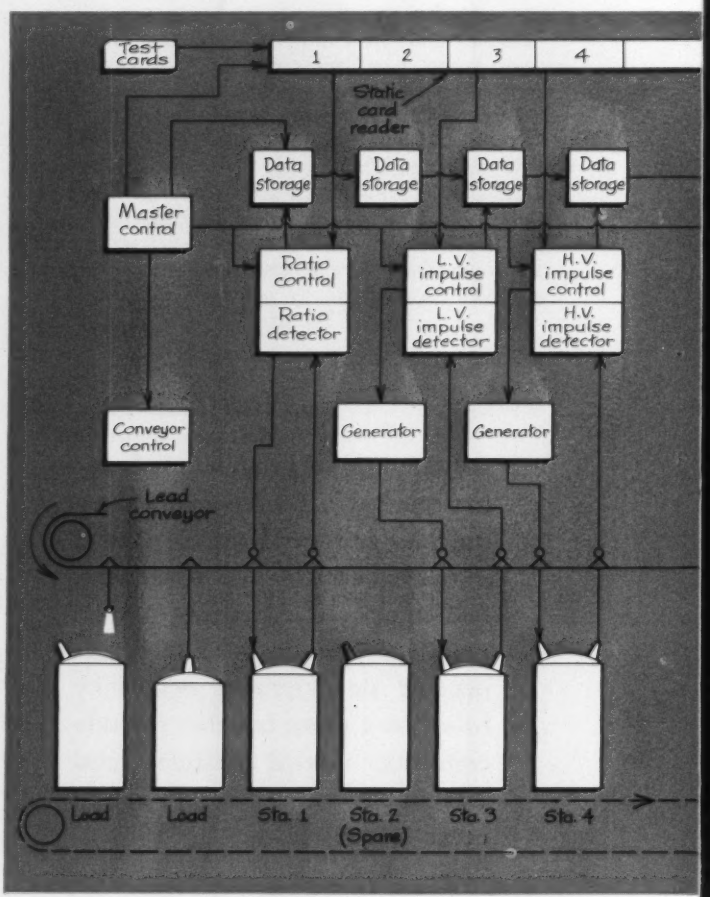
An important feature of the master control is the alarm system which indicates malfunctions in the facility. The general location of the malfunction is indicated by the monitor panel of the master control console. Alarm lights, one for each test station, are provided so the trouble can be localized at a glance. Among the malfunctions which are indicated by this system are: Tripped circuit breaker, failure to perform a programmed operation, improper test cycle, and three consecutive failures at any one test station.

In addition to the alarm signal, the monitor panel individually indicates the following for each test station: *Unit Present, Pass* or *Fail, Testing,* and *Manual* or *Automatic* control. By inspection of the master control monitor panel, the operator can see exactly what is taking place at each station. All test areas and all equipment cabinets are interlocked to prevent personnel from coming in contact with dangerous voltages.

In general, static controls were used wherever feasible. Telephone type relays, mercury-wetted contact relays, stepping switches, control relays, and contactors were also used. Required degree of reliability, switching load, circuit function, and cost were the governing factors in choosing circuit components.

▶ Data Handling

The data handling system of this facility transmits input data from a central data source to the test stations at a time and in a form so that they can be utilized to program the various tests, *Fig.* 4. In a similar manner, it transmits the resultant data from the test stations to a logging device. Test cards, of the IBM type, represent the source from which the system receives its programming data. One card is provided for each transformer tested. Since nine different transformers can be tested at one time, each receiving a different test, the data handling system sends information from nine different cards to nine different test stations at one time. Test results, which are obtained from the nine different test



stations as a transformer indexes through the line, are punched into the test card as the transformer completes its last test.

The heart of the data handling system is a specially designed card reader which will be described later. A Cypak system is the link between this card reader, the master control, and the test stations. It applies predetermined logic to signals from the card reader and the master control to program and control the test stations. In a similar manner, it stores the test results (as the tests are performed) until all tests are completed at which time they are punched into the test card.

Cypak circuits are also used to compare two digital quantities. Values of core loss measured at one of the test stations are compared with prepunched values from the test cards. The prepunched values represent upper limits of apparent and true watts. These comparisons are made with the numbers in a binary coded decimal form and produce a "more-than" (fail) or "less-than" (pass) output signal.

The static control components are housed in a separate cabinet. In order to facilitate trouble shooting they are arranged so that their relative physical positions correspond to their functional relationships. Power to the system is supplied by a motor-generator set. This provides a constant supply voltage and also isolates the system from power line transients which might "scramble" the logic signals.

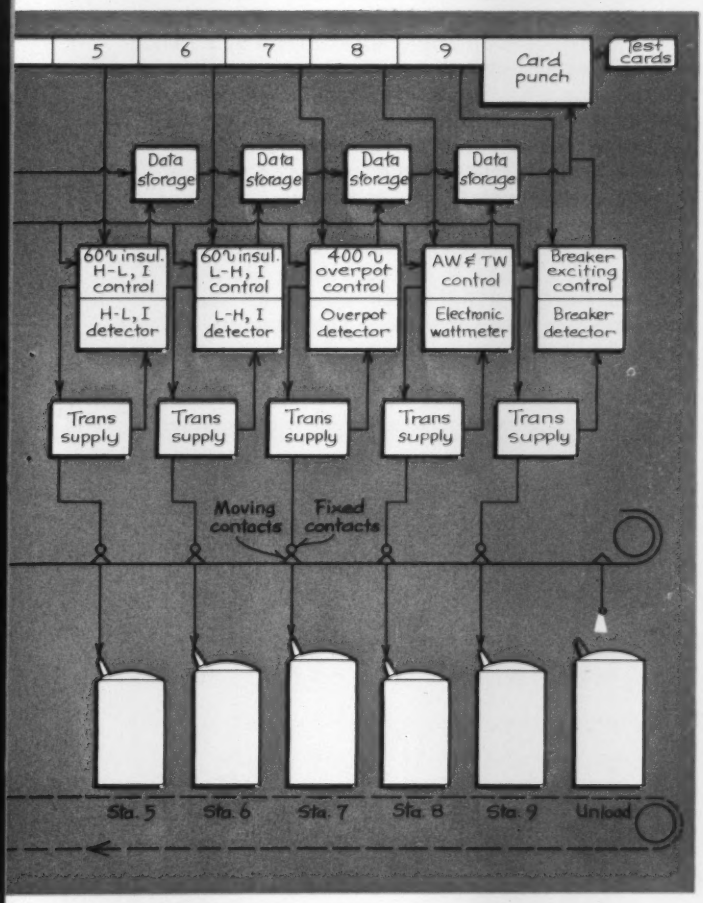


Fig. 4—Block diagram indicates general arrangement of main elements of the test facility. Control scheme provides that desired tests to be accomplished at each station are programmed by prepunched card. A card, corresponding to a transformer under test, indexes through nine reading positions. At completion of last test, results from all nine stations are punched into the card.

▶ Static Card Reader

The multistation static card reader, *Fig.* 5, was specially designed in an effort to increase the reliability, reduce the complexity, and reduce the cost of the data handling system. Basically, the device is a miniature indexing conveyor with ten stations. The first nine of these are reading stations and correspond to the nine test stations of the main conveyor. The tenth station is a logging station where the test results are punched into the test card. The card reader is synchronized with the main conveyor so that each test card passing through the reader corresponds to a transformer passing through the test line. Just as the main conveyor handles nine different transformers at one time, the card reader handles nine different test cards at one time. Since the card reader has nine reading stations, only the portion of the card that is pertinent to a particular test is read at the corresponding card reader station. It is this unique feature that makes this device particularly applicable to this type of facility.

If it were not for the static card reader, it would be necessary to read all of the information from each test card and then store this information until needed. This information would then be stepped along in a data storage system in synchronism with the units being tested. Appropriate information would be extracted from the storage system at each step. Since each test station would utilize a certain amount of this information, the quantity from any particular card would gradually diminish as the transformer proceeded through the test line. The storage elements for such a system could be electronic, electromechanical, or magnetic in nature. Although workable, such a system would be both bulky and expensive.

The reading assembly is a completely new design which employs star wheels as hole sensing elements. Each star wheel is attached to one end of a small lever which operates a set of electrical contacts. Twelve such mechanisms, one for each zone of the card, comprise a reading assembly. A maximum of four such assemblies can be used at each station, *Fig.* 6.

A static, as opposed to a momentary, signal is emitted from these devices. At any reading station, four columns of the test card can be read. For

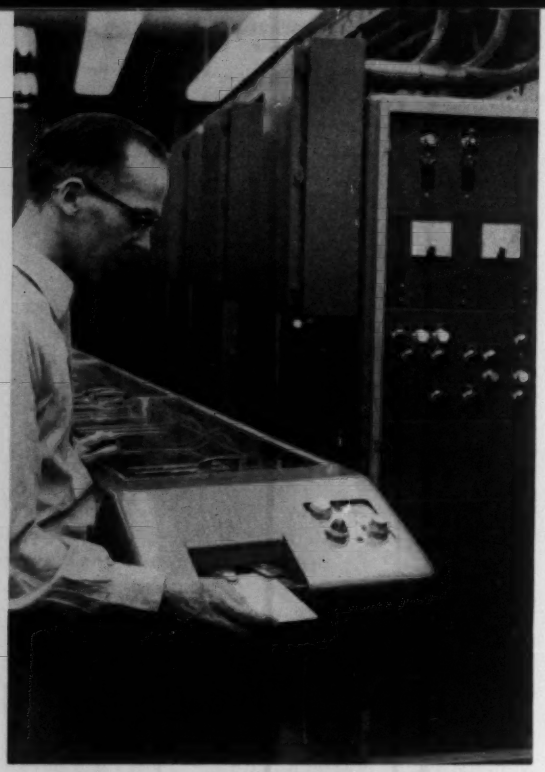


Fig. 5—Complexity of data handling system is considerably reduced by design of card reader. Device is essentially a 10-station indexing device that successively moves cards beneath nine reading heads and a single punching station. This versatile test facility does not require the internal information storage capability that might otherwise have been required.

example, columns 1, 21, 41, and 61 are read at Station 1; columns 2, 22, 42, and 62 are read at Station 2; etc. Other columns of the card are used for either prepunched information or the recording of test results.

All cards in the card reader index simultaneously by means of a reciprocating member driven through a single-revolution, solenoid operated clutch. Sensing switches are provided at all stations to detect the presence or absence of a card. This device is capable of handling cards which are soiled or bent and has proved to be quite reliable.

The punching station is a standard IBM keypunch which was purchased, modified, and made an integral part of the card reader. Many mechanical and electrical changes were required. The program drum was retained, however, to provide flexibility in punching and skipping.

▶ Test Equipment

The actual test equipment is located adjacent to the conveyor stations where the tests are performed, *Fig.* 7. All components, except the larger items, such as transformers and impulse generators, are housed in standard rack type equipment enclosures. These large transformers and generators are mounted on a balcony above the conveyor.

In most cases, voltage to the test stations is regulated. Values of voltage can be preset by setting limit switch cams on variable auto transformers. Both Cypak elements and relays are used for sequencing operations within the stations. The latter are employed only in the simpler cases where the use of Cypak elements would be impractical.

The test stations are normally programmed and controlled by the data handling system. For convenience of maintenance, however, each station can be switched to *Manual* and operated locally. This makes it possible to disconnect a test station from the rest of the system and trouble shoot it without shutting down the entire operation. Another convenient maintenance feature is the method of mounting terminal boxes on the side of each test cabinet. All circuits entering or leaving the test stations are terminated in these cabinets.

There are three possible results of a test: *Pass*, *Fail*, or *Bypass*. *Pass* or *Fail* is indicated by one of two signals; *Bypass* is indicated by the absence of either a *Pass* or a *Fail* signal and means that a legitimate test was not made. This could be because: 1. The test card called for the test to be by-

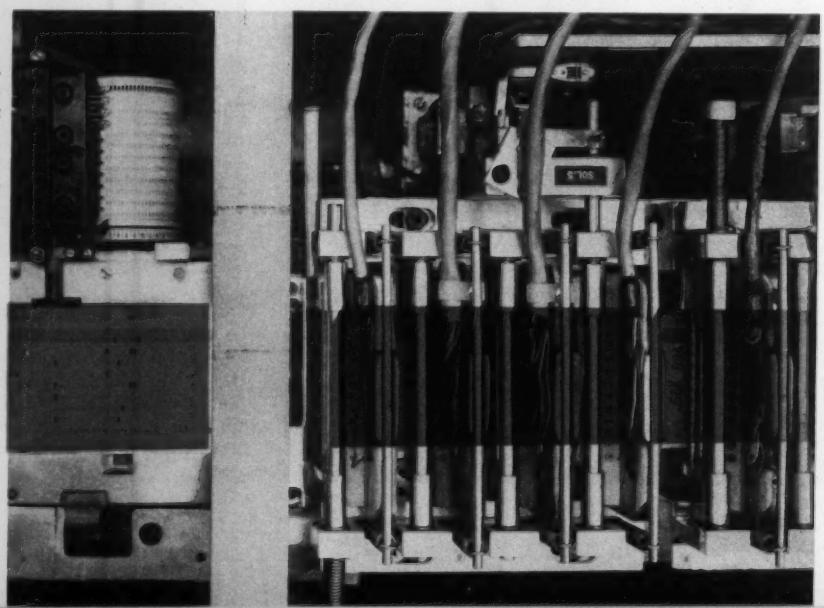


Fig. 6—Detail view of a portion of the card reader shows typical arrangement of the four reading assemblies associated with each of the nine reading stations. At any station, four nonadjacent columns are read (for example, columns 1, 21, 41, and 61). Each of the reading assemblies contains 12 star wheel mechanisms that sense the punched positions in the possible 12 positions available in each column on the card.

Fig. 7—Over-all view of test room shows four of the nine test stations (left); card reader (center); and Cypak logic panel (right). Conveyors are located behind the test stations. Normally controlled through the programming equipment, each test station can be isolated from the system for manual control and trouble shooting.

passed. 2. The test station was malfunctioning. 3. Subsequent tests were automatically cancelled because an earlier test failed.

The latter condition is a feature which prevents transformers from being needlessly destroyed. For example, if a transformer fails the first test, which is the ratio test, there is a possibility that the test card and the transformer are not properly matched. At a subsequent test station the mismatched card could program a voltage which was excessive for that transformer and thereby cause an insulation breakdown.

The result signals are picked up by the data handling system where they are stored until the transformer has completed its last test. At this time the results are punched into the test card. The data handling system summarizes these same signals and feeds them into a marking device located at the last station. This device automatically sprays a small color-coded spot on the transformer to indicate: 1. It failed a test. 2. It requires additional tests. 3. It passed all tests. This visual indication makes it possible for the operator at the discharge end to sort the units according to the next operation.

System In Operation

Operation of the facility requires two men. The first of these works near the card reader while the second is stationed at the discharge end of the conveyor. Test cards are identified to the transformers by serial number. Once the proper test card has been inserted into the card reader and the connections to the transformer have been made, the test cycle may be started. First, the conveyor and card reader index. The data handling system programs all test stations while the conveyor is indexing. All tests start automatically as soon as the index portion of the cycle is complete. While the tests are in progress, the operator pushes another transformer onto the loading section of the conveyor, and connects leads in preparation for the next cycle. The limiting factor of this operation is the testing portion of the cycle. Industry requirements specify that overvoltage must be maintained at the specified value for one minute.

Conclusion

Probably most notable of the innovations which have grown out of this facility is the static card reader. This device represents a straightforward, relatively inexpensive, and yet flexible means of programming sequential operations. So long as the test cards are matched to the transformers, they may be completely intermixed.

Numerous other engineering by-products have resulted from this project. For example, some of the circuits devised have been applied to other equipment in our plant and even in other industries. Another plus is the fact that the resultant test cards provide valuable design information in a form which can be conveniently tabulated by data processing equipment. Fast feedback of test results is an invaluable quality control tool. "Next day" reports allow corrective action to be taken fast. As a concise summation, the project has been effective not only in reducing costs, but also in providing a better product for the customer and a safer place to work for the employee, as well.

EVALUATING ECONOMIC FACTORS IN

CONTINUOUS HEAT PROCESSING

By **C. A. McFADDEN**, Manager, General Industry Div., Selas Corp. of America, Dresher, Pa.

MODERN trends and practices in heat processing of metals are a far cry from the old-time blacksmith shop or its present day counterpart — the heat treating department. No longer is an industrial furnace considered as just a brick-lined structure built to heat a material. By the same token, production line heat processing equipment is not just a furnace equipped with mechanical means to convey the material. Instead, today's modern heat processing equipment is specifically designed to take its place in the integrated, automatic production line and to provide a result considerably beyond mere heating to a process temperature.

In upgrading one's thinking on the technical concepts of modern day heat processing, one also must revaluate his approach to the economics of continuous heat processing. With automated techniques, heat processing can no longer be defined solely in terms of fuel cost and thermal efficiency. Rating a furnace on such a basis can be truly deceptive—in fact, efficiency, as applied to furnace operation, is totally misconceived if restricted to the ratio of heat input and heat absorbed. For example, no one

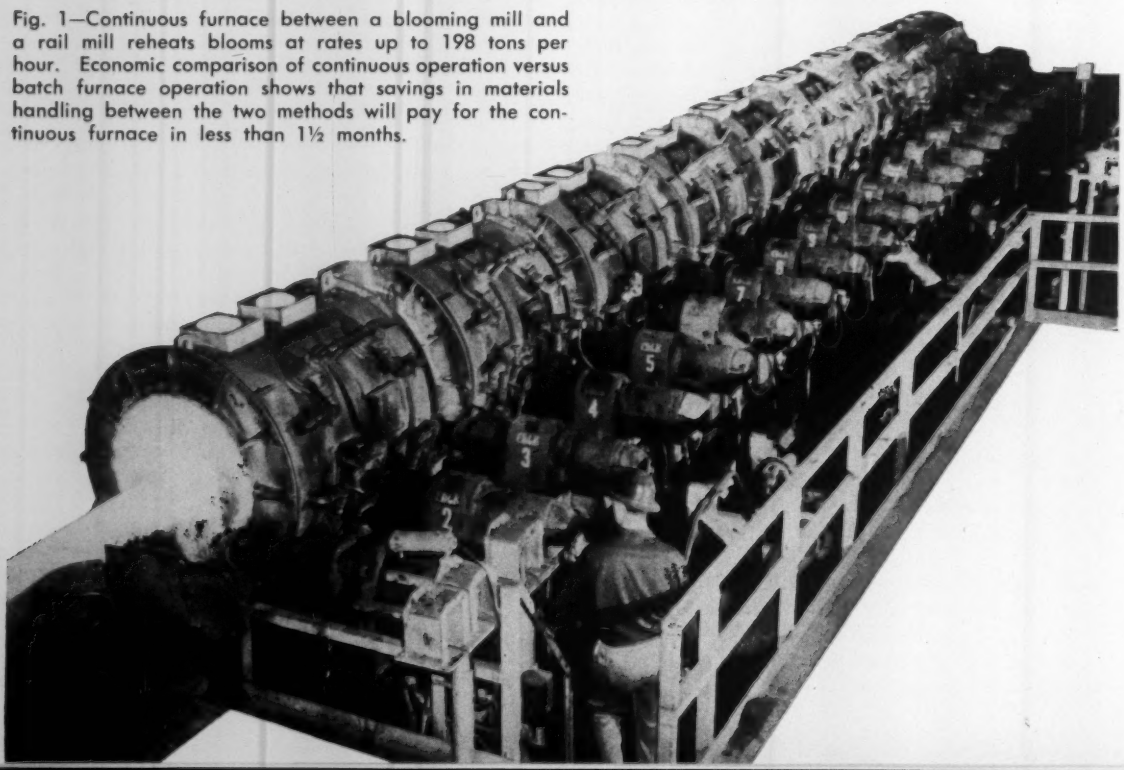


Fig. 1—Continuous furnace between a blooming mill and a rail mill reheats blooms at rates up to 198 tons per hour. Economic comparison of continuous operation versus batch furnace operation shows that savings in materials handling between the two methods will pay for the continuous furnace in less than 1½ months.

Evaluating the use of heat processing equipment solely in terms of fuel cost and thermal efficiency can be deceptive. The manufacturing engineer's economic appraisal should be based on the more important relationships encompassing the value of the product, the elimination of handling, and the design and reliability of equipment.

would define the performance of an automatic screw machine on the ratio of connected horsepower to average daily power consumption. Most continuous furnaces are not single purpose devices and should not be so considered or evaluated.

Fuel Efficiency Minor Consideration

Many different types of heat processing equipment are in use throughout the metalworking industry. A typical example showing the economics of continuous heating operations can be found in the reheating of blooms in a steel mill. When rolling a large ingot into a bloom, the surface cools by radiation and by frequent contact with the rolls. Therefore, prior to final rolling the bloom into a product, the conventional practice is to remove the bloom from the rolling process, put it into a batch-type reheating furnace, and reheat and soak it for ½ to 1 hour. The reheated bloom is then removed from the furnace and placed back onto the rolling mill table for final rolling. This practice involves at least two handlings of the steel by mechanical manipulators, a series of batch furnaces, and long heating times.

By introducing a continuous furnace between a blooming mill and a final rolling mill, a reheating operation is performed "on the fly" at a production rate up to 198 tons per hour in the installation shown in *Fig.* 1. The bloom is handled by conveyor rolls, and the process is automatic since the temperature of the bloom itself—not the furnace—is controlled by a radiation pyrometer. When no bloom is in the line, the furnace automatically goes on low temperature setting.

At this stage of processing, a reasonable value for a steel bloom might be $38 per ton. Based on a heat processing rate of 198 tons per hour, the mill rolls steel valued at $7524 per hour or $2.4 million per 40-shift month. In this case, the monthly production value of steel rolled is more than 12 times the cost of a continuous reheating furnace line.

When the economics of this installation are examined, it becomes apparent that fuel efficiency is not of major consequence in this process. Average fuel consumption using gas is 420,000 Btu per ton which calculates to a reheating fuel cost of 21 cents per ton. This cost is less than 0.6 per cent of the product value or about $13,300 for a 40-shift month. By adding gas recuperation equipment to the line, fuel efficiency could be increased by 50 per cent at the most and provide savings of $4440 per month. However, more than 3 years would be required to pay for the additional recuperation equipment from the fuel savings, neglecting entirely the maintenance cost of the equipment.

On the other hand, materials handling is a major cost in this process. It is generally agreed that it costs approximately $2 to pick up one ton of steel, transport it 100 to 150 feet, and set it down again. By using conveyors and eliminating a minimum of two handlings, at least $396 per hour is saved which is enough to pay for a new furnace in less than 1½ months. In addition to these savings, material losses due to scale will be greatly reduced. For example, a reheating time of 3 minutes in a continuous furnace against a heating and soaking time of ½ to 1 hour at 2250 F in a battery of batch furnaces accounts for a scale saving of 3 tons per hour at $38 per ton. This is equivalent to $36,480 per 40-shift month, or approximately 3 times the total fuel cost.

All benefits that accrue from the use of continuous furnace equipment cannot be translated into dollar savings. These would include improved end product due to more uniform bloom temperature, higher product quality because of reduced grain growth, and reduced decarburization due to shorter heating time. However, the savings illustrated should suffice to substantiate the contention that, on proj-

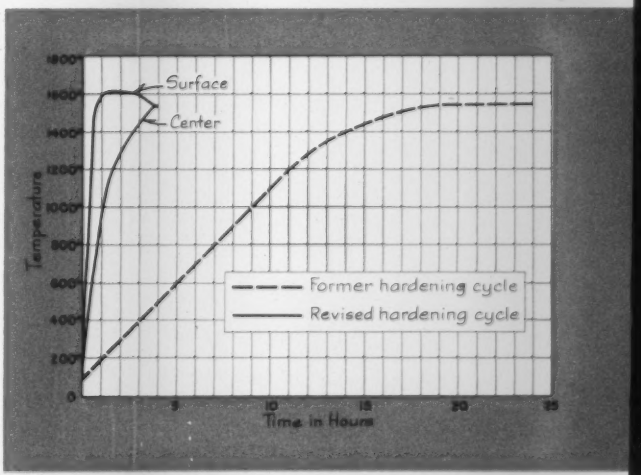
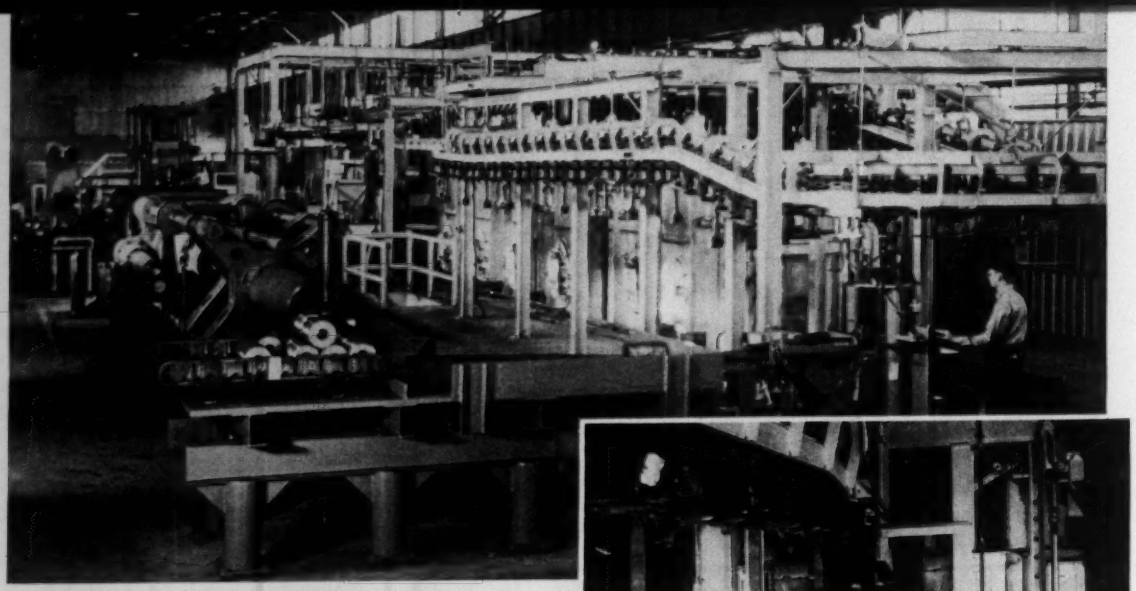


Fig. 2—Revaluation of heat processing cycle for hardening die blocks resulted in a reduction of heating time from conventional 24-hour cycle to a 4-hour cycle. One furnace now produces the same tonnage that formerly required 7 furnaces.



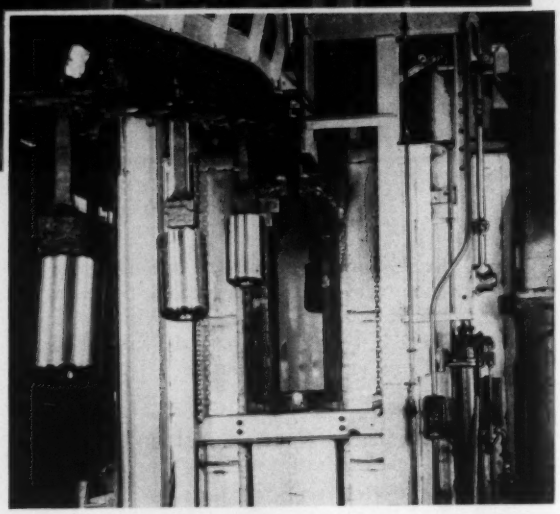


Fig. 3—Temperature uniformity and controlled oxidation were prime considerations in the design of this billet furnace for an extrusion installation. Inset shows the alloy billets being conveyed through the furnace without touching the walls or hearth to achieve the close temperature tolerances.

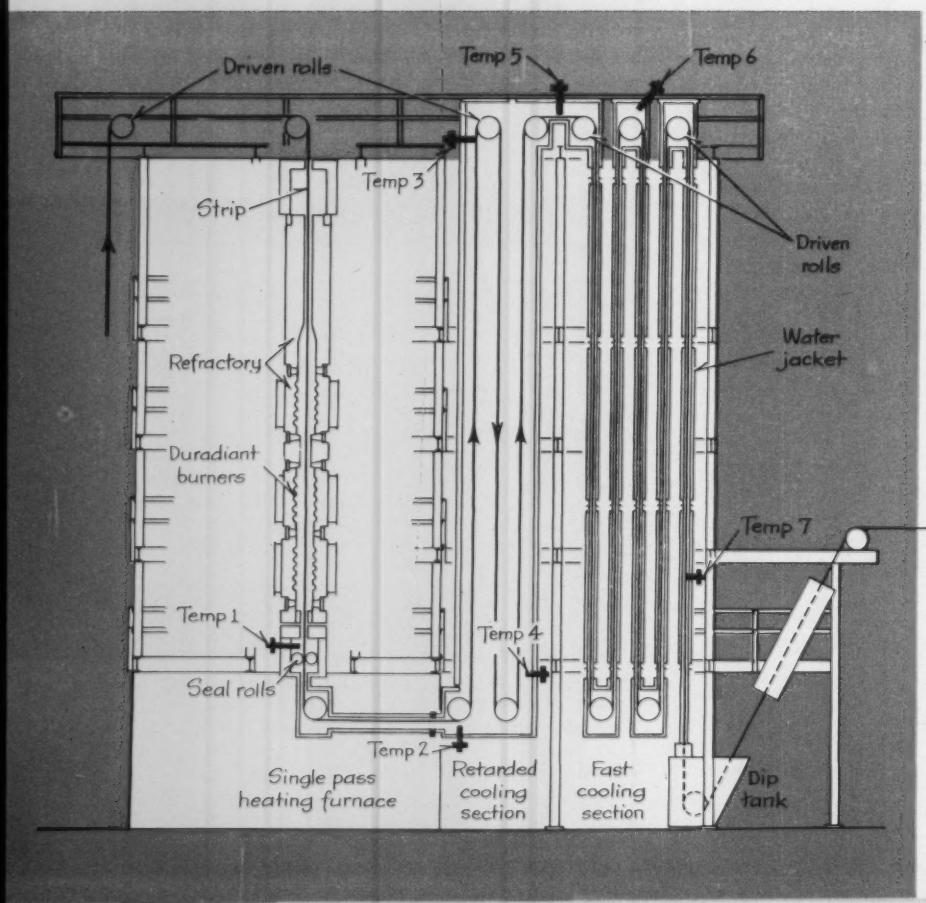


Fig. 4—Continuous bright annealing of steel strip at speeds up to 1000 feet per minute are made possible by this single-pass annealing furnace. Processing time of 4 seconds heating and 45 seconds cooling is a major improvement over batch annealing which requires up to 200 hours exposure in order for the heat to penetrate coiled stock or sheet packs.

ects of this nature, fuel efficiency alone is often inconsequential in comparison to other factors and costs. Of course, the continuous equipment must be well-designed and well-built. Production stoppages, due to mechanical or operational failures, can represent a loss in production value equal to the total equipment cost. Therefore, when inter-connecting continuous furnaces to mill or other processing operations, reliability and performance must receive top consideration.

Heating Misconceptions Retarded Progress

If major savings and satisfactory results can be obtained by fast, continuous heating, it seems logical to ask why this was not done long ago. The answer seems to lie in the misinterpretation of long experience. Mistaken ideas about heating potentials were accepted as rules and basic standards of design, even material specifications. For example, 1 hour per inch was the "rule" for heating large steel sections to forging or rolling temperature. Such "rules" were based on a misinterpretation of results and facts. Bad or nonuniform heating techniques—the only ones in existence because of the state of development — were translated into metallurgical results and retarded progress for many years.

The heating cycle for an 18-inch thick die block, as specified by the "rule," is shown by a dotted curve in *Fig.* 2. Solid lines represent the heating operation now performed on the same die block, and many tons of first quality, sound, and solid blocks have been produced at 1/6 of the former operating cycle with substantial savings in time, material, and equipment. Today, an up-to-date furnace produces the same tonnage as formerly produced in 7 furnaces, with less fuel, less scale, less labor, and less material in process. In this process, fuel efficiency is again of minor consequence when compared to other factors. Fuel cost is approximately

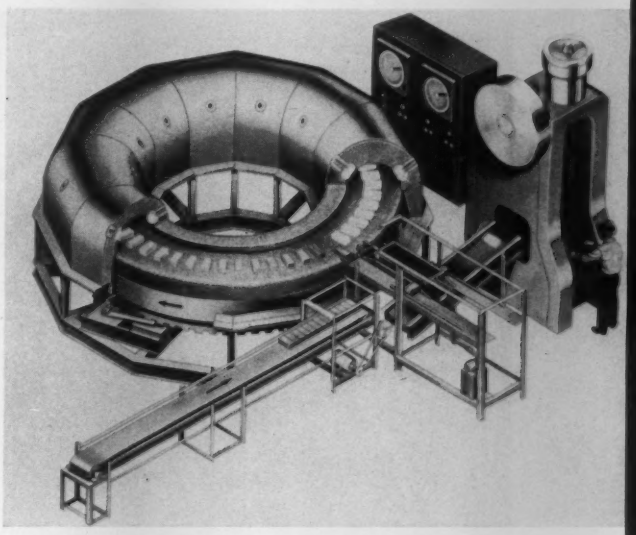


Fig. 5—Sketch illustrates the basic design for a rotary hearth furnace that feeds a forging hammer of press. Billets are conveyed to the loading device, mechanically charged onto the rotating hearth at the rate of 5½ tons per hour, mechanically unloaded after heating, and automatically conveyed to press.

$1.80 per ton, and product value in 6 shifts exceeds the cost of the furnace. One spoiled furnace charge is worth more than 60 times the total fuel cost.

With old rules and false misconceptions discarded, it became feasible to consider heating of heavy sections on a continuous basis with many associated advantages and benefits. The steel and alloy billet heating furnace, *Fig.* 3, provides a good example. In this case the furnace is only a small part of an extrusion installation, but a variation of a few degrees in billet temperature will cause the product quality to be outside commercial dimensional tol-

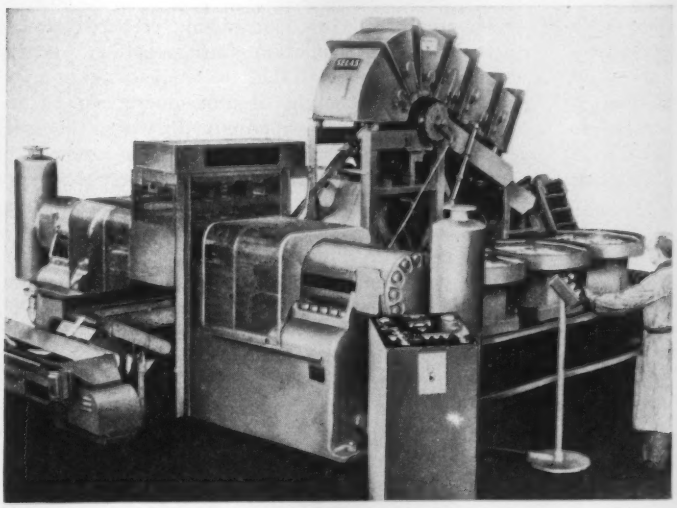


Fig. 6 — Automatic forging machine equipped with a continuous conveyor-type furnace produces 40 aluminum parts per minute. Entire process uses approximately 15 cents worth of natural gas per hour. Although only a small amount of fuel is required, it must be burned and used with close control or improper heat could result in a large scrap loss.

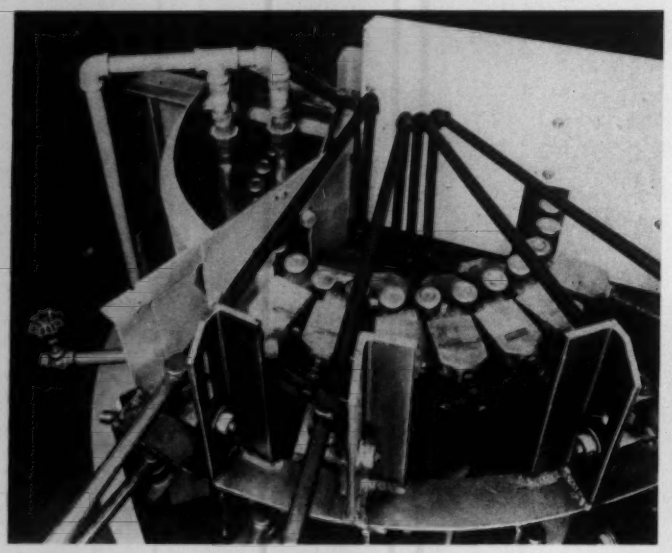
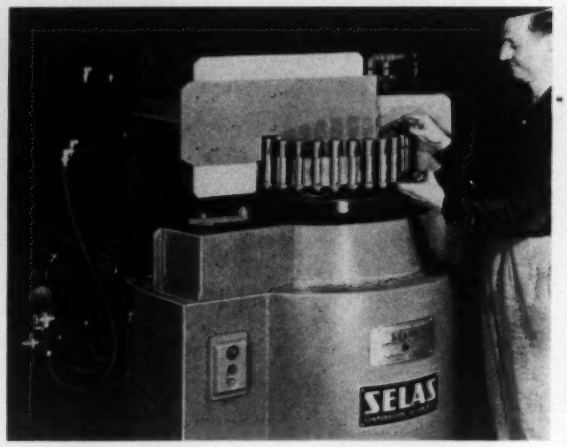


Fig. 7—Furnaceless heat processing machine is used to anneal the side wall portions of brass door knob blanks. Top view of machine shows the blanks being rotated at 20 rpm as they are conveyed past gas burners. Each burner is balanced to fire at a different portion of the side wall area. The transition zone between the annealed side wall and the hard top is held to less than ⅛ inch. After exiting from the last burner, the piece is water cooled to restrict heat creep.



erances. This fact and controlled oxidation were prime considerations in the furnace design and adoption.

For fast and absolute heating, the billets are hung on welded studs and are carried through the furnace by a continuous conveyor at a rate of 8 tons per hour. The billet touches no wall or hearth and is in ideal position to be heated uniformly. Actual heating is accomplished by radiant burners in the side walls, and only the products of combustion—no flame—are inside the furnace chamber surrounding the billet. Radiation supplies 80 per cent of the heat. Product value of only 7 hours operation at rated capacity represents more than the cost of the furnace, due to the high basic cost of the extrusion alloys.

▸ Continous Strip Annealing

Similar radical departures from conventional practices and concepts are evident in heat processing light steel sections. Continuous bright annealing of steel has now become an accepted process, at speeds up to 1000 feet per minute on steel strip 0.010 inch thick by 48 inches wide—and even higher speeds are contemplated. These installations require a high capital investment, $1.5 million and higher, but they have been and are being made, primarily because of product improvement.

When tinplate stock is batch annealed in coils or sheet packs, annealing cycles up to 200 hours are necessary to penetrate the work. Under these conditions an appreciable difference in time-at-temperature exists between the center and the outside of the work. In continuous processing, the total cycle time has been reduced to 4 seconds heating and 45 seconds cooling with each foot of strip going through identical treatment conditions. Although the continuously treated steel is harder than conventionally annealed strip, the steel has better drawing qualities. Increased stiffness permits the use of thinner or lighter gage steel for cans and containers. Therefore, the continuous furnace again provides a treatment process result considerably beyond the mere heating of material to annealing temperature.

Process diagram of a single-pass, continuous steel strip annealing furnace is shown in *Fig.* 4. The strip is heated to annealing temperature in one downward pass through a direct fired furnace unit. Close control of the combustion process prevents the formation of scale. The strip then enters a retarded cooling section and a fast cooling section, both of which are filled with nonoxidizing prepared atmosphere to prevent oxidation during cooling. At strip temperatures below 600 F, water cooling can be applied, or the cooling in atmosphere can be extended, without any apparent difference in steel properties and surface appearance. It is noteworthy that no beneficial change in steel properties accrues from holding the strip at temperature for any time longer than can be reasonably incorporated into a continuous operation.

This continuous steel strip annealing line has the capacity to handle a product value of over $800,000 per month, or almost double the cost of the furnace equipment. Fuel cost for this production amounts to $9400 per month, and with a minor addition to the existing equipment the cost can be lowered to less than 1 per cent of the product value. Product value alone represents over $1200 per hour. This figure emphasizes the unimportance of fuel effi-

ciency when compared to the great importance of reliability of equipment. In any continuous production line, the reliability factor controls the number of different operations that can be safely and justifiably integrated.

Rotary Furnace

Another example of an automated continuous furnace is a rotary hearth furnace, *Fig.* 5, which is designed for heating steel billets to forging temperatures. Billets are mechanically charged onto the rotating hearth, mechanically removed after heating, and conveyed to a forging hammer or press. An industrial furnace of this type, with a mean hearth diameter of 13 feet 9 inches, is capable of heating 5½ tons of billets per hour with fuel consumption of 2.34 million Btu per ton. This gives a fuel cost of $1.80 per ton without the use of recuperation equipment. Product value at the entry to the furnace is approximately $57 per ton. The furnace and mechanical equipment cost would be equal to about one 40-shift month's output in product value.

Scale produced during the 11 minute heating cycle on a 4 inch square billet is 0.004 inch thick, measured on a broken clean surface of a billet. This is less than 0.25 per cent scale loss by weight against a normal accumulation of 1½ to 2 per cent when heating to forging temperature in a conventional forge furnace. Using only 1 per cent scale reduction gives a saving of $1000 per 40-shift month when using continuous furnace equipment. Additional benefits accrue from higher product quality, reduced machining costs, and other factors. Fuel control, automatic timing, and reduced grain growth resulting from accelerated heating cycle are contributing factors to this successful operation.

Forging, Annealing, and Brazing

Hot forging of aluminum tail fins for U. S. Navy rockets, *Fig.* 6, is another example of continuous metal processing. Production rate is 40 pieces per minute. Aluminum blanks are hopper fed into heat resistant work holders attached to a chain conveyor. The holders continuously convey the blanks through a 1600 F radiant gas fired furnace, heating them to 900 F.

The blanks are then automatically transferred to a forging machine, or impacter. In three automatic operations the blank is formed into a slug or billet, forged to shape, and trimmed to remove flash. The entire process uses approximately 15 cents worth of natural gas per hour which is approximately 0.04 per cent of the manufacturing cost. This minute quantity of fuel must be burned and used with such precision that improper heat for as little as 60 minutes could result in a scrap loss of at least $1000.

A manufacturer of locks and similar hardware uses a furnaceless heat processing machine, *Fig.* 7, to precisely anneal the side wall portion of a cup-shaped brass blank for a door knob. The anneal is restricted to the side wall area, keeping the end or face fully hard since this surface receives no further cold work. An over-all anneal in a furnace or oven would produce too soft a finished product.

The annealing machine is only one part of an integrated and automatic production line which converts brass blanks into finished door knobs at speeds up to 60 per minute. Fuel cost for the annealing machine is less than $10 per 40-hour week. During this same period of time, the value of the product processed greatly exceeds the original cost of the annealing equipment.

Another type of heat processing used in industry is automatic brazing. A manufacturer of window type room air conditioners uses an indexing dial machine, *Fig.* 8, to simultaneously braze as many as 80 return-bend joints on air conditioner coils at a rate of 30 coils per hour. Each coil is comprised of aluminum fins tightly fitted onto copper tubes which are joined in a continuous circuit by silver brazed return bends. A typical coil is worth about $10.50 at the time of brazing.

Approximately 200 cubic feet per hour of natural gas is used in this operation, and labor costs

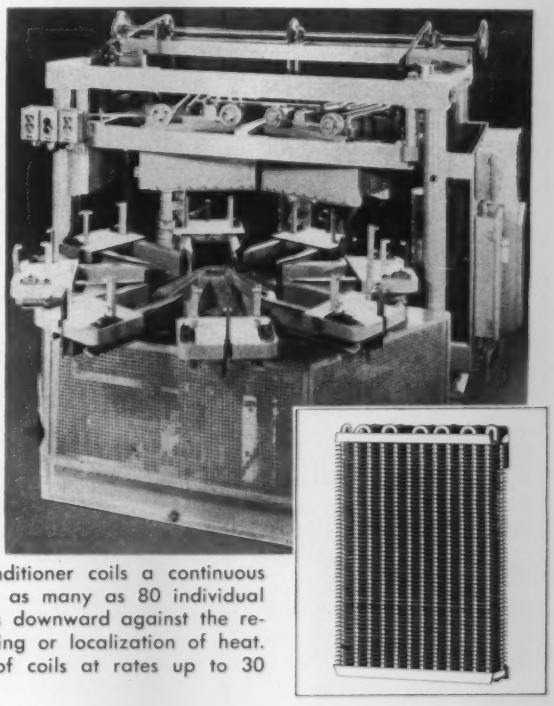


Fig. 8—Indexing dial machine makes brazing of air conditioner coils a continuous operation. Inset shows a typical coil which can contain as many as 80 individual joints requiring silver brazing. A gas radiant panel fires downward against the return bends and eliminates the necessity for precise focusing or localization of heat. Machine will handle many sizes, shapes, and patterns of coils at rates up to 30 coils per hour.

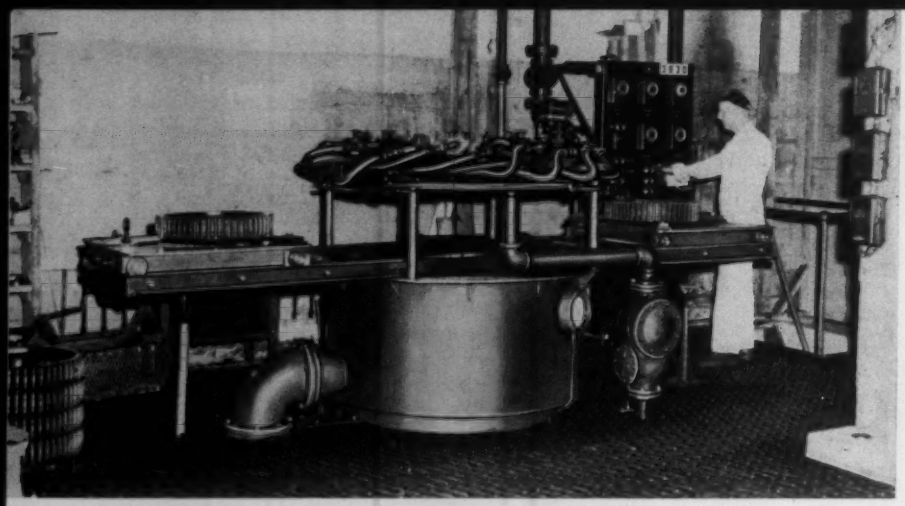


Fig. 9 — Automatically controlled equipment is used to surface harden the teeth of large gears. Each gear is rotated inside a ring of adjustable gas-air burners which heat the tooth surfaces so rapidly that the gear body stays below the hardening temperature. The gear is then transferred quickly into an oil or water quench tank located below the burners.

for the automatic brazing averages about 20 cents per coil. When compared to hand torch brazing techniques, the productivity per worker has been increased 4 to 5 times. With fuel consumption of less than 7000 Btu per coil, the fuel costs are of minor importance when compared with the efficient use of space and labor.

▸ Flame Hardening

The teeth of heavy-duty gears can be flame hardened to improve the wearing quality of the gear without imparting brittleness to the teeth. This can be accomplished on automatically controlled equipment as shown in *Fig.* 9. The important considerations in this equipment are its ability to selectively harden the surface of the teeth, its adaptability to a wide variety of gear sizes and shapes, and its use of natural gas fuel. Because of the wide variety of gear sizes and shapes processed, it is difficult to make a single economic analysis. One example would be a gear with a 22-inch pitch diameter by 4-inch face, weighing about 160 pounds. Value of this gear would be worth about $150 at the time it is hardened. Such a gear is brought to hardening temperature in about 6 minutes with a total of 10 minutes required for a complete cycle of heating, quenching, unloading, and reloading. At an input of 1 million Btu per hour, fuel costs are but a small fraction of the gear value, and 6 day's production in terms of workpiece value more than covers the original cost of the machine. Amortizing such a flame hardening machine over a full year's production adds less than 2 per cent to the cost of the gear at this stage of manufacture.

Continuous heat processing is a valuable tool in the manufacturing engineer's continual search for better and faster ways to produce a product. However, in evaluating the use of this tool, the engineer must relegate the so-called equipment rating —thermal efficiency and fuel input—to its proper place in the over-all economic analysis of the operation under study. Major importance should be placed on such items as cost of handling, value of materials processed, and design and reliability of equipment. Continuing research and development in gas fired heat processing equipment will result in greater acceptance of this method as a precise and controllable processing tool.

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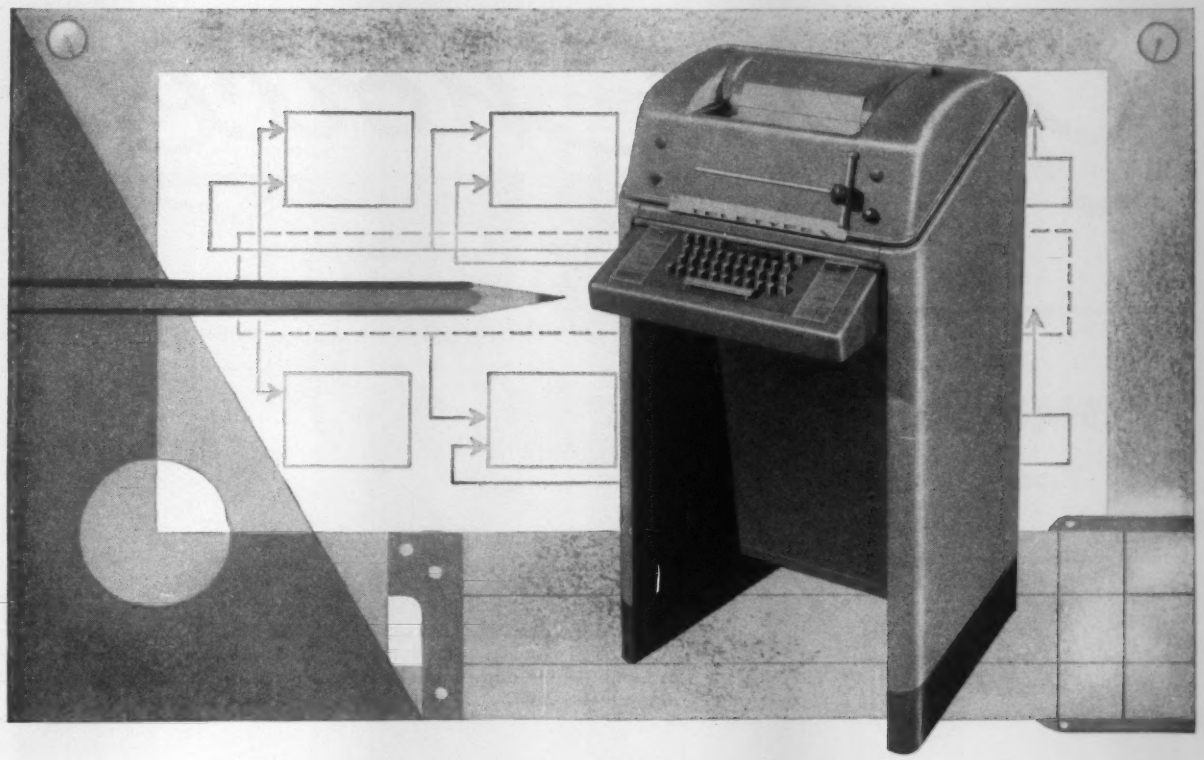

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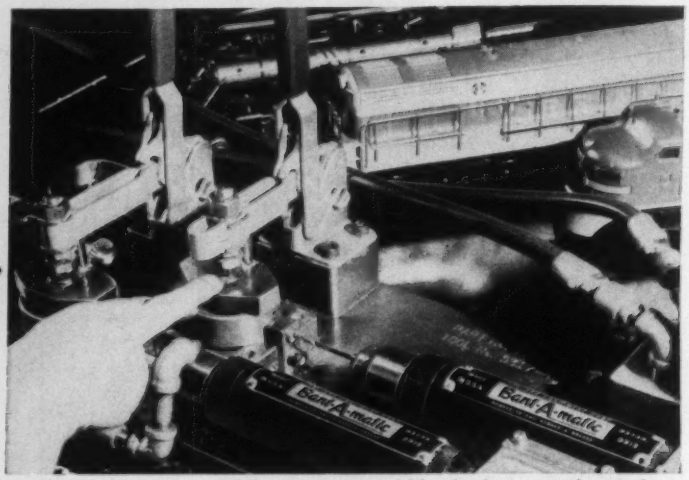

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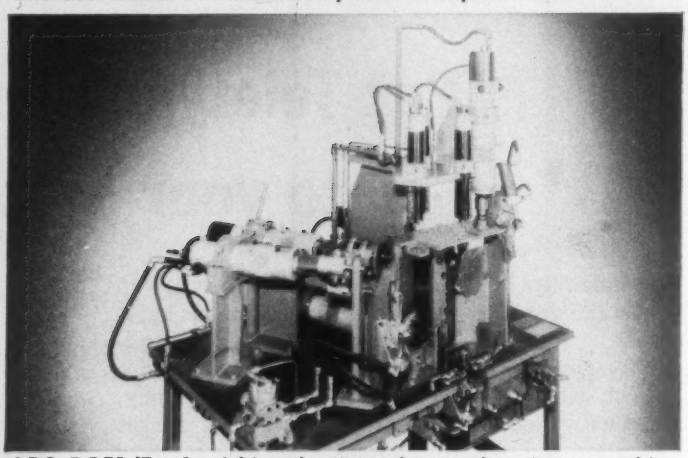

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Circle 654 on Page 17

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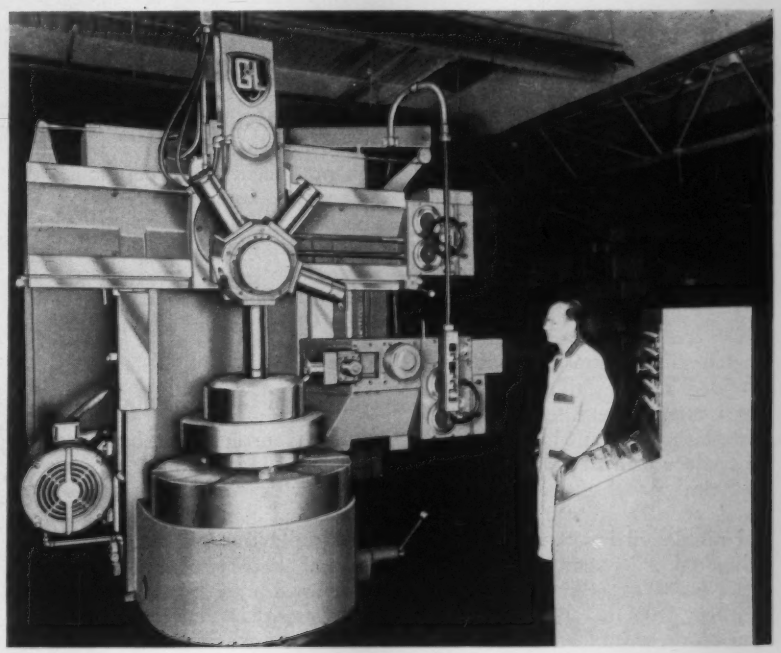
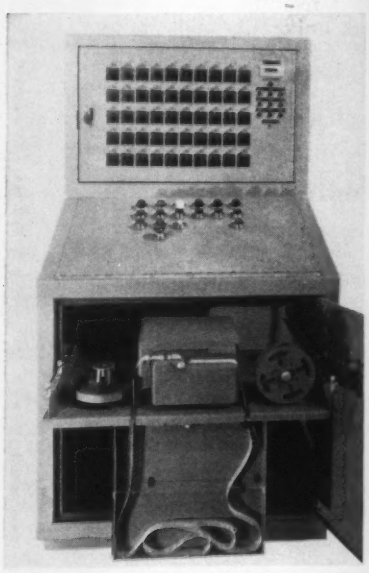
For detailed information and literature, use card on page 17.

Punched Tape Controlled Vertical Turret Lathe

PRODUCTION savings, increased dimensional accuracy, and improved quality of finish of workpieces are possible with a punched tape controlled vertical turret lathe designed and built by **Kaukauna Machine Div., Giddings & Lewis Machine Tool Co.**, Kaukauna, Wis. Actions such as tool positioning, turret indexing, tool feeds, tool dwell, and table speed are automatically controlled on company's standard vertical turret lathe by means of 8-channel paper or plastic-metal foil laminated tape. The control system is designated Numeripoint. Preparation of a program is in two steps: Production of a tape manuscript by a programmer, and copying of the manuscript by a typist using a standard electric perforating typewriter.



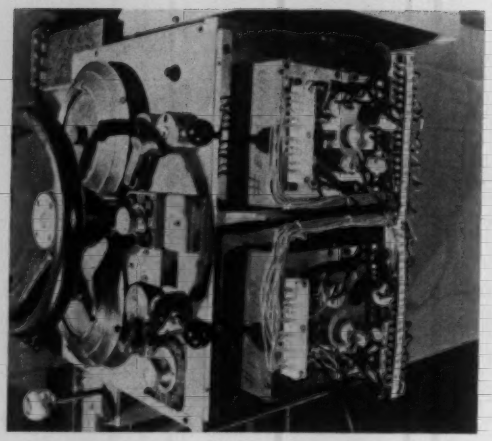
Punched tape controlled vertical turret lathe is equipped with control console, right, which programs machine actions such as tool positioning, turret indexing, tool feeds, and table speeds. Two workheads can be controlled automatically.



View of control console shows 8-channel tape reader in lower compartment. Loop storage box permits use of endless tapes for repetitive manufacture of identical parts. Supply and take-up reels accept longer tapes, which may program different parts sequentially. Up to 50 special adjustments can be set on dials on vertical panel. These settings override tape instructions to insert special positioning adjustments when required.

The tape can control the operation of any two workheads, such as a rail and a side head, or two rail heads. When a head function requires a special adjustment, as for close-tolerance work or for tool wear, an adjustment number is coded on the tape for that function. When this number is read on the tape, the control will automatically insert a preset override adjustment set on dials by an operator.

A selector switch on the control console permits either manual or tape controlled operation of the machine. The tape cycle can be interrupted at any time with no loss



Close-up of control station for rail head shows feed setting dial, micrometer position indicating dials with adjustable stops, and handwheel used for manual positioning. Portion of station with cover removed contains feedback resolvers that sense head positions. Operator can allow machine to position automatically to a program location, then disengage resolver units for manual repositioning.

of data previously read into the system.

In manual operation, a pendant control is used to provide rapid changes of table speeds. A total of 24 individual speeds may be selected on a dial on the pendant. Individual feed rate selector dials are provided for each workhead. Both table speed and feed rate may be changed while a tool is engaged for cutting.

Control Console

The control console contains a motorized tape reader which is mounted on a sliding shelf in a lower compartment. All operating controls are mounted on the sloping surface of a control panel. On a vertical panel above the control panel are 50 adjustment controls and numbered lamps which permit individual adjustment of up to 50 cutter positions within ±0.010 inch of their nominal settings. Each adjustment control is selectable from the punched tape and, during programming for cuts where wear or deflection are encountered or where tight tolerances are required, the programmer will program an adjustment control. The adjustment is made during setup. In subsequent machining operations, the tape will automatically select the proper preset adjustment control and machining will be completely automatic. Also on the panel are alarm indicators which give a visible signal when a machine malfunction occurs.

Individual Control Stations

Each turret lathe head has its own individual control station complete with circular scales, selector dials, and control levers. The feed and rapid traverse box, which is a part of the control station, is a self-contained unit providing 20 independent feeds that increase in geometric progression. A feed rate selector dial selects any feed by a turn of a knob. By turning the dial to the desired rate, the head will automatically operate at that setting when a feed control lever is shifted. Feed of the tool can be changed at any time without stopping the cut. The operator can also override any tool stop setting by pressing a button in the center of the feed selector dial. This permits manual positioning by means of a handwheel. Coaxial micrometer reading dials, with 8-inch diameter circular scales, are graduated for full linear tool positioning. Five adjustable tool stops can be set on the circular scales.

Numerous safety features are incorporated in the basic machine. Unless the handwheels on the machine are in neutral position, automatic operation cannot be started. This feature protects the operator from possible injury by rapidly rotating wheels. Overtravel limit switches prevent damage to the machine in the event the operator should attempt to run the slides beyond their normal extreme positions. In numerically controlled operation, all data are checked for codes which are not acceptable to the control; the machine motion is stopped when an error in coding occurs.

Tape controlled vertical turret lathes are available in 32, 42, and 52-inch diameter table sizes. Systems offer the benefits of improved scheduling and pricing because of predetermined production cycle times; reduced inventories; greater machine utilization; less operator skill required; and improved product uniformity and quality.

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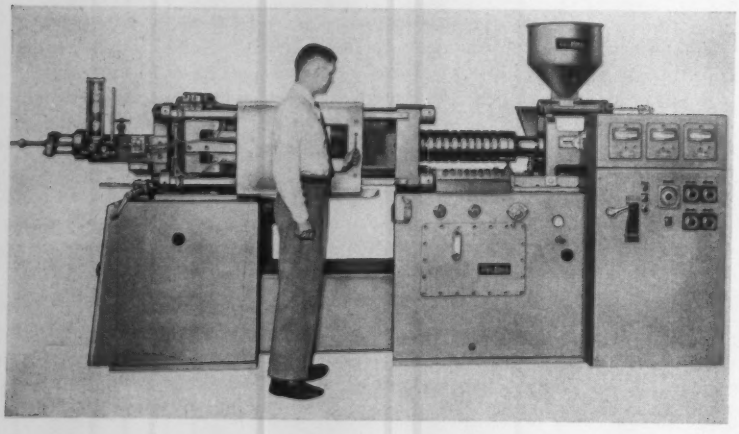
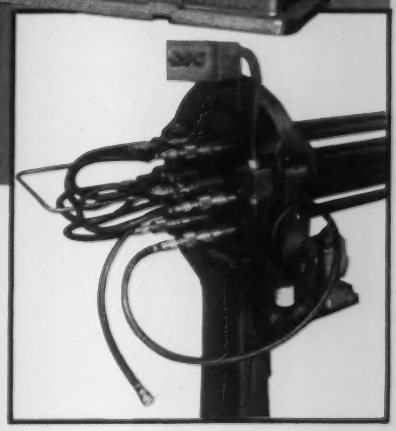


Molding Press

Item 402

Equipment has a plasticizing capacity of 100 lb of polystyrene per hour, features a double toggle lock to provide sufficient leverage for high clamping pressure. The high clamping pressure used results in parts of uniform size, since the molds cannot spread apart when the material is injected. 840 cycles per hour can be obtained.

The press has dual safety controls—an electrical interlock and a hydraulic dumping valve. If one



A Natural

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Feed Out Stock to 16½"
Eliminate Pushers and Feed-Out Cams

Removable fittings attach air lines to the stock reel tubes. A vacuum pump withdraws the piston when restocking. Push-button control panel is provided for starting and stopping.

Greenlee Air-Feed Automatics offer you a 3-way profit advantage:

1. Maintenance and change-over time is reduced by eliminating stock pushers, feed tubes and feed-out cams.
2. Stock can be automatically air-fed to position in one or more machining stations permitting two or more pieces per cycle.
3. Multiple feed-out flexibility enables you to finish machine a variety of pieces that ordinarily demand costly second operation setups.

If you are running into production headaches on a specific job, Greenlee may be able to adapt an "Air-Feed" to solve your problem. See your Greenlee Distributor.

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Circle 680 on Page 17

control fails, the other is available to protect the operator. The plunger refill stroke is adjustable for use whenever multiple stroking or filling of the heating cylinder is required. The heating cylinder can be moved away from the stationary platen by means of a hand-operated hydraulic cylinder. There is space provided under the molds of the press so a conveyor can be placed to receive the parts as they are molded. **Van Dorn Iron Works Co.**, 2685 E. 79th St., Cleveland 4, Ohio.

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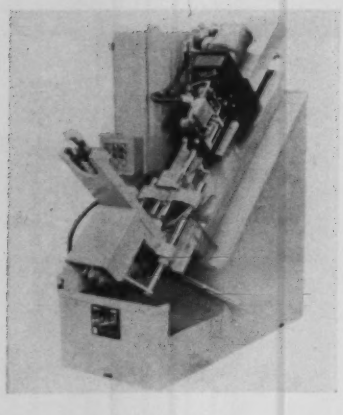

Drilling/Tapping Unit

Item 403

Equipment can automatically drill and tap three holes with a single stroke, using three 2-flute taps with drill points ground on their ends. It also automatically feeds, locates, clamps, and ejects the part. Model 24 is equipped with a special lead screw attachment for tapping. The control system provides rapid travel of the tools to the work surface, hydraulically controls the feed during the drill portion of the stroke, and also provides lead screw control for tapping. For withdrawing the tap, the electric drive motor is reversed.

The fixture is mounted at a 45 degree angle to facilitate loading and allow gravity feeding of parts. The parts are dropped into machining position and released by an air-operated rocker arm escapement. The released parts roll out a side discharge chute onto a conveyor where they continue to the next work position. Production rate is said to be 600 parts per hour. **Hause Machines Inc.**, Montpelier, Ohio.

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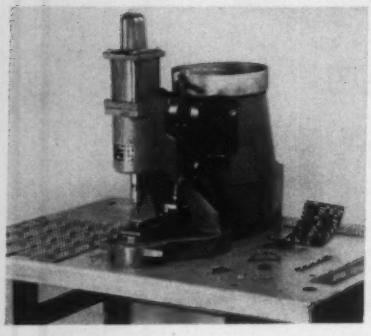

Terminal Setter

Item 404

Designed to feed and set up to 100 turret or seamed terminals per minute in terminal boards, Model FST is also adaptable for feeding and setting contacts, pins, shoulder studs, and plug nuts. A built-in variable voltage transformer provides control of impact. Impacts ranging from a light tap to 3500 lb are available.

In operation, terminals are automatically oriented and fed to a staking nest from a vibratory feeder. The operator places a board over the terminal and actuates the terminal setter with a foot switch, staking the terminal in the board. As the operator withdraws the board, the power-driven feed automatically advances the next terminal to the nest. A light source under the punch head helps in properly placing the board. **Black & Webster Inc.**, 445 Watertown St., Newton, Mass.

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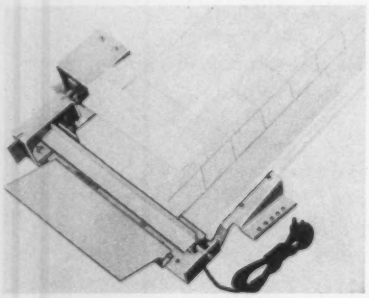

Automatic Dispenser

Item 405

Trip-out dispenser can be used with automatic warehouse handling equipment as well as in production line operations, or in any sorting operation where items of less than case lots are to be dispensed. Unit is solenoid-operated and can be actuated by automatic selection equipment. In operation, the individual items are stacked together on an inclined chute. When the dispenser is actuated, a revolving gate opens and permits one item to be released from the chute onto a waiting conveyor belt or into a box. The gate automatically locks the next item in place and will not release it until the dispenser is actuated again. **Industrial Electronics Engineers Inc.**, 3973 Lankershim Blvd., North Hollywood, Calif.

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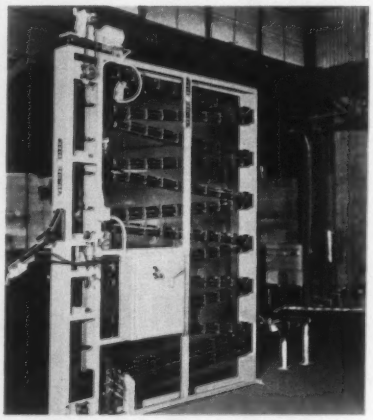

Float Storage Unit

Item 406

Equipment can store pipe fittings or similar parts that can roll, is adaptable to handle three different sizes of parts. Storage unit is comprised of zig-zag gravity part-retaining tracks which are fed by elevator. A bypass track permits direct passage of parts through the unit when desired. Built-in five-digit counters can be supplied in the control panel to provide a running parts inventory.

In operation, parts are fed from a distribution system to an entry at the lower right end of the unit where they are gravity fed to a parts elevator and are raised to the top of the cabinet where they roll into the first section of tracks. Each part traverses the full complement of tracks, which includes five sections. Parts leave the unit from an exit chute at the middle left end of the cabinet. A limit switch in the exit chute shuts off the equip-

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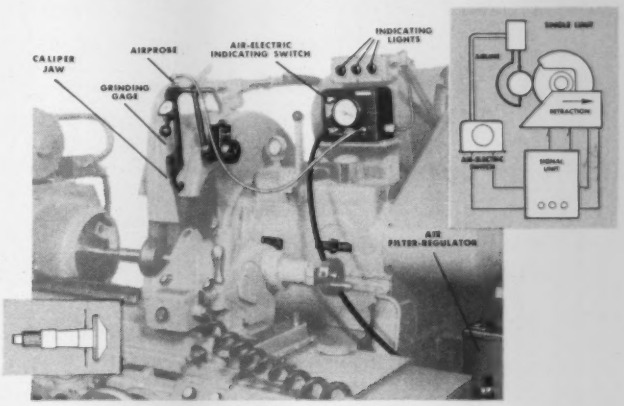
① AUTOMATIC CONTROL OF FINISH SIZE

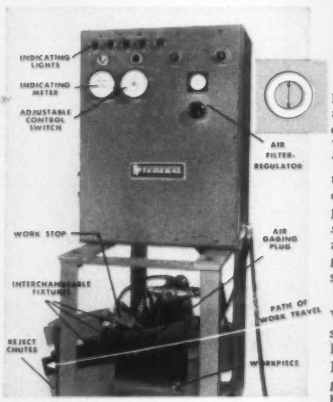
This standardized control gage continuously measures and indicates size of work as it is being ground and automatically causes wheel to retract the instant finish size is reached. Unit can be easily applied in the field to any center type grinder having hydraulically controlled wheel slide.

BENEFITS: Reduces costs — one operator handles two, possibly three grinders performing the same or different operations. Gages pay for themselves within a few months.

Improves quality — even if you have only one grinder, gage is a profit-maker because it eliminates error due to operator inattention or fatigue and also eliminates cost of later inspection.

VARIATIONS: Similar FEDERAL Gages are available through machine tool manufacturers to change wheel feed rate to dwell grind also . . . or to control dressing cycle and finish size on I.D. grinders. When specifying machine tool requirements be sure to include Federal gaging.



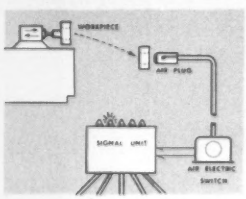


② AUTOMATIC 100% INSPECTION

This standardized "post-process" gage inspects every part as it is discharged from the machine and sorts work into "good", "*near*-over", "*near*-under" plus "salvage" and "scrap", indicating the size of each piece. Operator can compensate for drift and piece-to-piece variation *before any scrap parts are produced.* Can be applied to any type I.D. or O.D. grinder, lathe, boring machine or screw machine.

BENEFITS: Lower cost per part. Virtually eliminates scrap by showing trend *before* tolerance limits are reached.

Eliminates inspection errors — gage has 99.8% reliability or better.



VARIATIONS: Federal Gages of similar type are available through machine tool manufacturers to also provide automatic compensation of the machine, either proportionally or by increments, so that drift is corrected without need for operator attention. Be sure to specify Federal Gaging when buying machine tools.

③ SEMI-AUTOMATIC, MULTIPLE DIMENSION MEASUREMENT

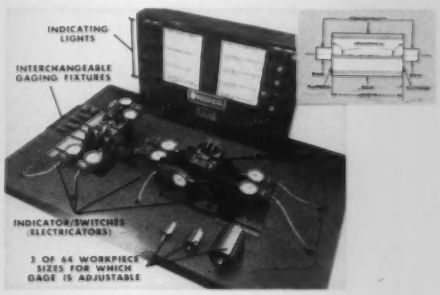
Ideal for small and medium production manufacturers, this gage checks nine dimensions in two stations and is adjustable for 64 sizes! Work is loaded and disposed of manually. Lights show "good", "over" and "under".

BENEFITS: Reduces non-productive costs—inspection time per part is reduced 75%.

Improves quality level. Permits profitable 100% inspection.

Inspection can be performed by less skilled personnel.

VARIATIONS: Can be designed to provide virtually any combination of dimensional measurements. Unit can incorporate semi-automatic disposal. Other design possibilities up to a completely automated inspection and control gage.


INDICATING LIGHTS
INTERCHANGEABLE GAGING FIXTURES
INDICATOR SWITCHES (ELECTRICATORS)
3 OF 64 WORKPIECE SIZES FOR WHICH GAGE IS ADJUSTABLE

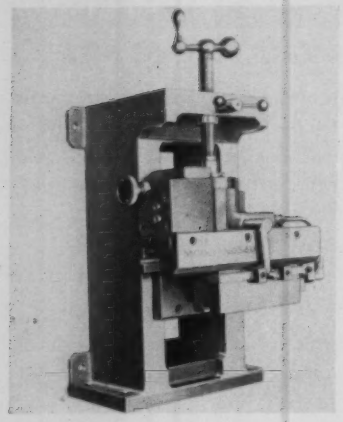
Ask **FEDERAL** *First*

FOR RECOMMENDATIONS IN MODERN GAGES . . .

Dial Indicating, Air, Electric, or Electronic — for Inspecting, Measuring, Sorting, or Automation Gaging

ment if parts back up. When used for stockpiling, the unit stops when full. **Gear-O-Mation Div., Michigan Tool Co.**, 7173 E. McNichols Rd., Detroit 12, Mich.

Circle 406 on Page 17



Marking Device

Item 407

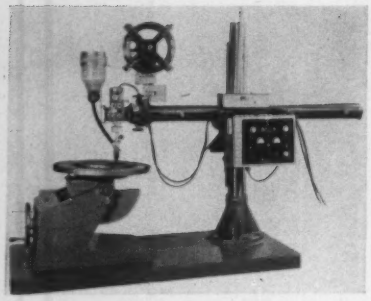
Hydraulically operated roll marking unit can be mounted right side up, upside down, sideways, at any angle or location. When the device is used as a machine station, parts can be marked while in fixtures on rotary feed tables or in-line transfer units. Model 58 U is equipped with a built-in oil reservoir, oil filter, motor, and pump system, pressure regulator, and foot actuator. Travel of slide from left to right is ¼ to 3½ inches; travel of head up or down, ½-inch maximum. Head adjustment is 4 inches, distance between uprights, 5¼ inches. Marking rate is 50 strokes per minute. A maximum stamping pressure of 800 lb can be exerted. **Cadillac Stamp Co.**, 17309 Ryan Rd., Detroit 12, Mich.

Circle 407 on Page 17

Welding Fixture

Item 408

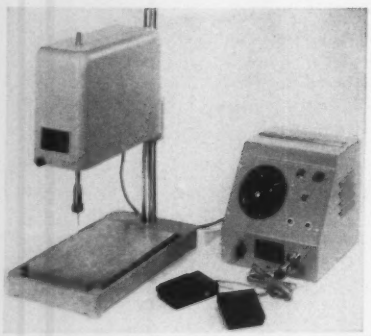
Flexible manipulator for automatic welding consists of a vertical mast and horizontal boom mounted on a base which may be either pedestal or cylindrical type. Infinitely adjustable travel speeds are from 10 to 150 ipm. The boom is powered by a ¼ hp, 110 v dc motor; maximum clearance of the boom is 42 inches, and the effective weld



length is 42 inches.

The mast is made of tubular steel and has a rack to provide vertical movement of the boom on the mast. The vertical lift speed is 12 ipm through a gear box powered by a ¼ hp, 110 v dc motor. The mast will pivot 360 degrees and can be locked in any position. A control panel which is optional provides for speed control of horizontal movement, forward and reverse switching, and up and down switching. It can be mounted on the manipulator or remotely. **Miami Specialties Co.**, Trade Rd., Troy, Ohio.

Circle 408 on Page 17



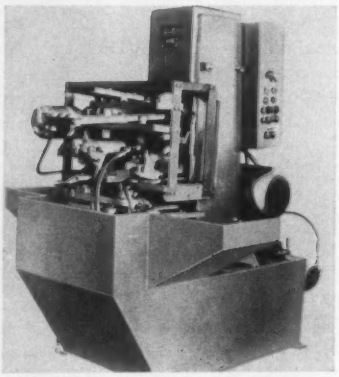
Lead Screw Tapping Unit

Item 409

Unit is designed for the small hole tapping of delicate parts. It is recommended for through or blind hole tapping of all thread sizes from 0-80 to 10-32 in all types of workable materials. Up to 120 threads per inch can be produced, however. The automatic tapping cycle of the machine is actuated by footswitch or pushbutton, or the cycle can be actuated by the workpiece itself when it is positioned properly under the tap.

The tap is fed into and retracted from the work at a controlled rate governed by a single master lead screw. Change gears for different threads are easily installed. An adjustable friction clutch is incorporated in the unit to allow precise control of torque delivered to the tap. Tap stroke is adjustable from ⅛ to 2 inches and the tapping speed is infinitely variable. Cycle time, depending on pitch and stroke, can be as high as 3000 cycles per hour. **Milman Engineering Co.**, 1831 Pontius Ave., Los Angeles 25, Calif.

Circle 409 on Page 17



Abrasive Belt Machine

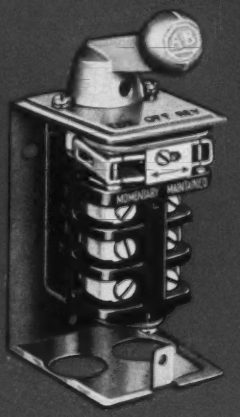
Item 410

High-speed, precision grinder is capable of grinding rotors to diameter within ±0.001-inch and concentricity within 0.0005-inch. Rotors from 1 to 4½ inches in diameter can be handled with Model BG8/HT. The rotor fixture consists of a regulating wheel and double or triple feed and discharge tracks. The rotors are placed on parallel sets of inclined feed tracks and roll down to a machine-load position. Simultaneously with loading, the regulating wheel moves forward to hold the parts firmly in V-ways.

The table infeed sequence is in two stages: First, a rapid approach to the grinding position; and second, a controlled uniform infeed movement as the work is beltground. A lateral, reciprocating motion of the table utilizes the full width of the belt. When the rotors are sized to the desired diameter, a gage registers and actuates the machine table, which then retracts. This gaging device provides constant in-process gaging throughout the grinding cycle. As the regulating wheel moves back from the finished set of rotors, the rotors are deposited on discharge tracks by

ALLEN-BRADLEY

REVERSING DRUM SWITCHES



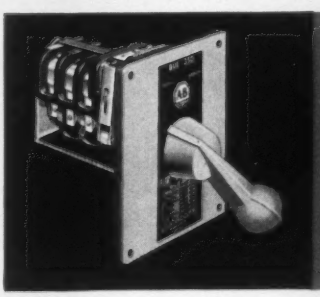
BULLETIN 350

Style A wrap-around cover is removed to show the readily accessible front wiring terminals. Max rating: 2 hp.

. . . styled to match the most modern production machines!

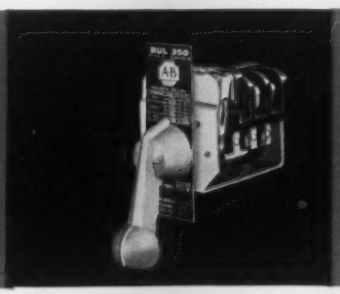
Inside and out—this Allen-Bradley drum switch is *all* new. Its trim, modern lines and attractive die-cast aluminum handle will give your production machines "up-to-the-minute" styling.

But there is more than beauty to this new switch. The rugged switch mechanism is a self-contained unit—independent of the enclosure. Misalignment and binding *cannot* occur. The base mounts directly on machine surfaces—without using spacers. And with the wrap-around cover removed, terminal screws are exposed for fast wiring—from the front. Changeover from momentary to maintained contact operation can be made in seconds. Investigate this new "leader" in its field. Send for Publication 6091.



OILTIGHT CAVITY MOUNTING

A-B Style AF reversing switches can be furnished with sealed shaft and rubber-gasketed, oiltight cover for cavity mounting in a machine base.



PANEL MOUNTING

The new Style A switches can be furnished for mounting directly on panels. Nameplate which gives ratings is also included with each switch.

ALLEN-BRADLEY

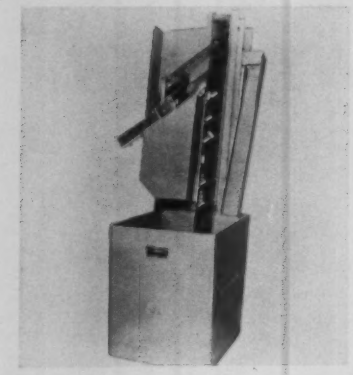
Quality Motor Control

Allen-Bradley Co., 1339 S. First St., Milwaukee 4, Wis.
In Canada: Allen-Bradley Canada Ltd., Galt, Ont.

Circle 682 on Page 17

ejection fingers. Another set of rotors is dropped from the feed tracks to the V-ways and the cycle is automatically repeated. **Engelberg Inc.**, 831 W. Fayette St., Syracuse 4, N. Y.

Circle 410 on Page 17

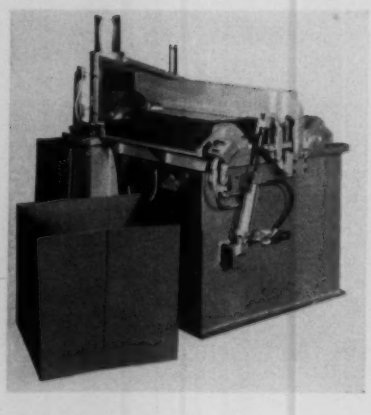


Elevator Feeder

Item 411

Automatic, portable feeder can handle sliding or rolling parts. Model 2200-C can feed sliding parts ½ to 3 inches long with diameters of ⅛ to 1 inch, and rolling parts from ⅜ to 3 inches in diameter and ⅛ to 1 inch in thickness. Loading height is 38 inches above the floor, with the take-off available on the left or right hand or both. Hopper capacity is 6 cu ft and the cleated belt width is 6 inches. **Feedall Inc.**, 38399 Pelton Rd., Willoughby, Ohio.

Circle 411 on Page 17

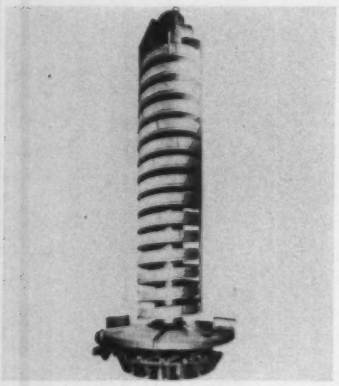


Tangent Bender

Item 412

Open-end, single-wing tangent bender is designed for narrow products less than 6 inches wide, such as tubing, angles, and channels. Model 6 ASW 2 has a rapid operation cycle, requires no front clamping mechanism. Machine can be used in combination with company's welding equipment to form a line which will provide a steady production flow from flat sheet to formed and welded units. Other machines in line of smaller types of equipment include single-wing, duplex, and quadruplex tangent benders which will handle material from 24 to 48 inches wide. **Taylor-Winfield Corp.**, Warren, Ohio.

Circle 412 on Page 17



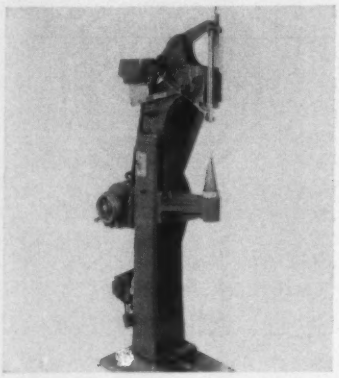
Spiral Dryer/Conveyor

Item 413

Vertical vibrating conveyor screens while conveying and permits continuous sampling. The equipment can be used for heating, cooling, and drying of products such as ammonium nitrate, pelletized dynamite, ammonium sulfate, and flake caustic. The spiral elevator conveys material up a helical ramp with a lifting-twisting vibrating motion.

Air or products of combustion for drying, heating, or cooling are introduced to an inlet at the top of the unit and are passed down a center tube and out through holes across conveyed material. Indirect heat transfer is accomplished with water sprays under troughs carrying the material. The natural frequency drive principle uses heavy coil springs to store energy and provide positive operation. **Carrier Conveyor Corp.**, 211 N. Jackson St., Louisville, Ky.

Circle 413 on Page 17



Long Rivet Setter

Item 414

Machine can automatically feed and set semitubular and full tubular rivets up to 0.260-inch body diameter and 2⅝-inch length. Model 95DP has a 10-inch throat and either 4¼-inch or 5-13/16-inch stroke. Center-hung clamping type jaws are equipped with rigid arms and secondary leaf springs to control and hold the rivet securely. Standard jaws can handle any 0.260-inch diameter rivet regardless of head diameter. The clamping action takes place after the riveting cycle has been actuated, leaving the rivet to hang free so that it can be pushed aside when added clearance is needed. When equipped with auxiliary feeding parts such as a pull-down anvil pin, hinge post, and a special hopper, the machine can feed and set rivets up to 5⅜-inches long. **Tubular Rivet & Stud Co.**, Quincy 70, Mass.

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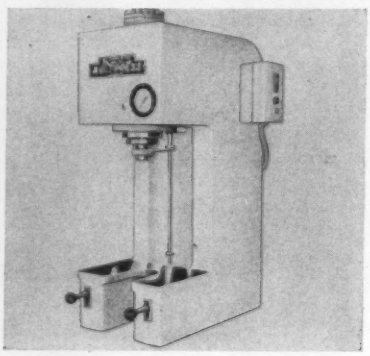


Bench Press

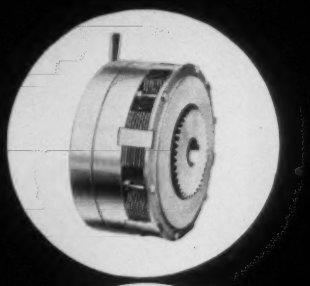
Item 415

Line of presses is designed to operate at low hydraulic pressure

4 reasons why YOU should use Fawick Magnetics . . .

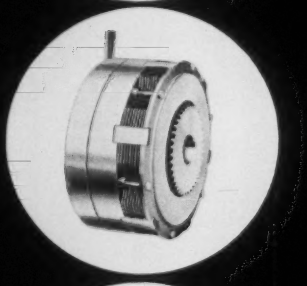
all providing better operation at lower cost!

INSTANT RESPONSE



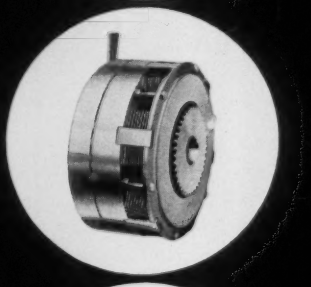
The design features of FAWICK Magnetics provide instant engagement or disengagement of the multiple discs under either wet or dry operation. This permits fast, accurate programming of machine operations from all types of modern electrical or electronic controls.

CONTROLLED TORQUE



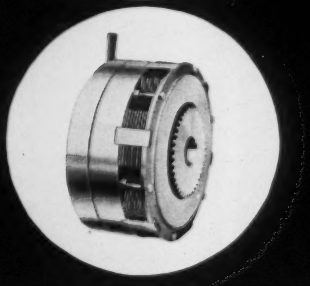
Torque produced by FAWICK Magnetics is easily established and accurately controlled through the FAWICK design which incorporates a straight-line relationship between applied coil voltage and torque output. This permits — in addition to straight starting, running and stopping operations — a wide range of torque-limiting applications.

SMOOTH ACTION



FAWICK Magnetics provide exceptionally smooth, shock-free engagement and disengagement through multiple precision driving and driven discs. Automatic adjustment for normal operating wear insures "new clutch" performance throughout long service life.

COMPACT and COMPLETE



FAWICK Magnetics are supplied "ready for installation" and do not require assembly on the machine. Their high-efficiency performance provides a compact, small size with an excellent torque-vs.-size ratio that is practically adaptable to streamlined machine design.

These basic FAWICK Magnetic advantages are but a few that you can utilize for your machine designs. For full information call or write your nearest FAWICK representative or the Home Office, Cleveland, Ohio.

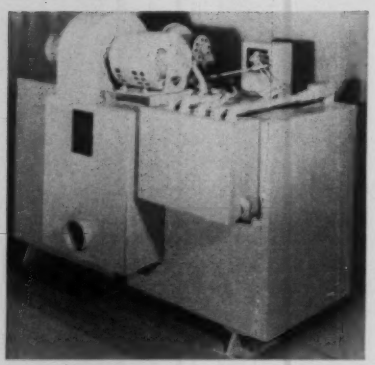
FAWICK AIRFLEX DIVISION
FAWICK CORPORATION
9919 CLINTON ROAD • CLEVELAND 11, OHIO
Fawick Canada, Ltd., 60 Front St., West, Toronto, Ont., Canada

FAWICK MAGNETIC
INDUSTRIAL CLUTCHES AND BRAKES

Circle 683 on Page 17

for applications such as assembly, crimping, forming, broaching, and trimming. The press is a self-contained unit of C frame design. Models are available in 2 to 8 ton capacities. Features of the press are: Control system with safety provisions, accurate duplication of pressure on succeeding ram strokes, removable hydraulic power unit, and fast setup. Units operate on 220 or 440 v, 60 cycles, three phase current. **Denison Engineering Div., American Brake Shoe Co.**, Columbus 16, Ohio.

Circle 415 on Page 17



Dehumidifier

Item 416

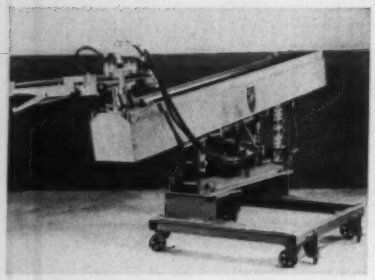
Compact, dual tower adsorption dehumidifier is capable of handling up to 70 cu ft of air per minute. It is suitable for humidity control in unheated spaces or low temperature installations. Model A12 can remove as much as 30 lb of water vapor per 24 hours. Dehumidifier is an automatic, self-contained unit which can be installed either inside or outside the space to be controlled. It can maintain close tolerances (± 0.5 per cent relative humidity) in a cabinet, oven, or stream of air. **Universal Dynamics Corp.**, Box 9814, Arlington 9, Va.

Circle 416 on Page 17

Side-Arm Extractor

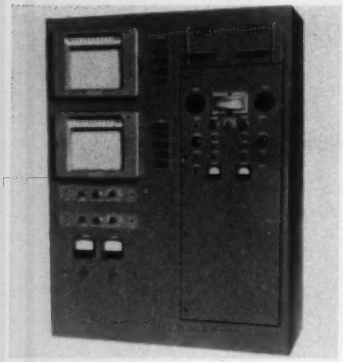
Item 417

Automatic press extractor has a wheel-mounted base for portable use in the press room. Stroke length of the extractor is 8 feet; over-all length of unit is $9\frac{1}{2}$ feet. The jaw assembly can be moved on the frame so that it can operate on either the left or right side. Height



and angle of extraction are also adjustable. A feature of the unit is a self-cleaning, angular track which automatically sheds foreign matter. Where double dies are used in a large press, two extractors can be used, mounted either separately or on a common base. **Sahlin Engineering Co. Inc.**, P.O. Box 289, Birmingham, Mich.

Circle 417 on Page 17



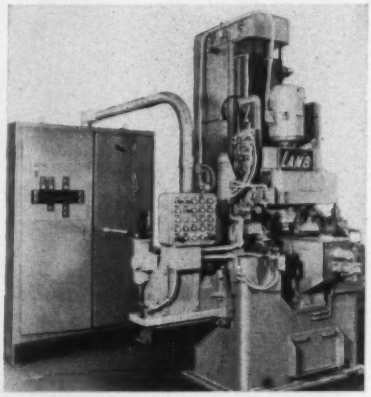
Ionization Detector

Item 418

Instrument is capable of automatically separating, identifying, and permanently recording different chemical substances present in gaseous and liquid products. It is applicable in the petroleum, chemical, and compressed gas industries. Model 10 (shown) is capable of either single or dual-column operation using glass, metal, or capillary columns. Unit is relatively insensitive to changes in gas flow, temperature, and pressure because ions produced in the chamber are collected rapidly at the electrode (within 10^{-3} or 10^{-2} seconds). The sensitivity range can be increased or decreased by means of two selector-switching arrangements, which permits an analyst to work with fractions of a gamma, gamma, or several milligram quantities. The column compartment and the detector compartment are both independently housed and have individual temperature control systems.

An available accessory is an automatic cooling system which provides quick cooling for column compartments that have been operated at elevated temperatures. The system can provide a temperature cooling rate of 3 to 7 C per minute. **Wheelco Instruments Div., Barber-Colman Co.**, Rockford, Ill.

Circle 418 on Page 17



Piston Milling Machine

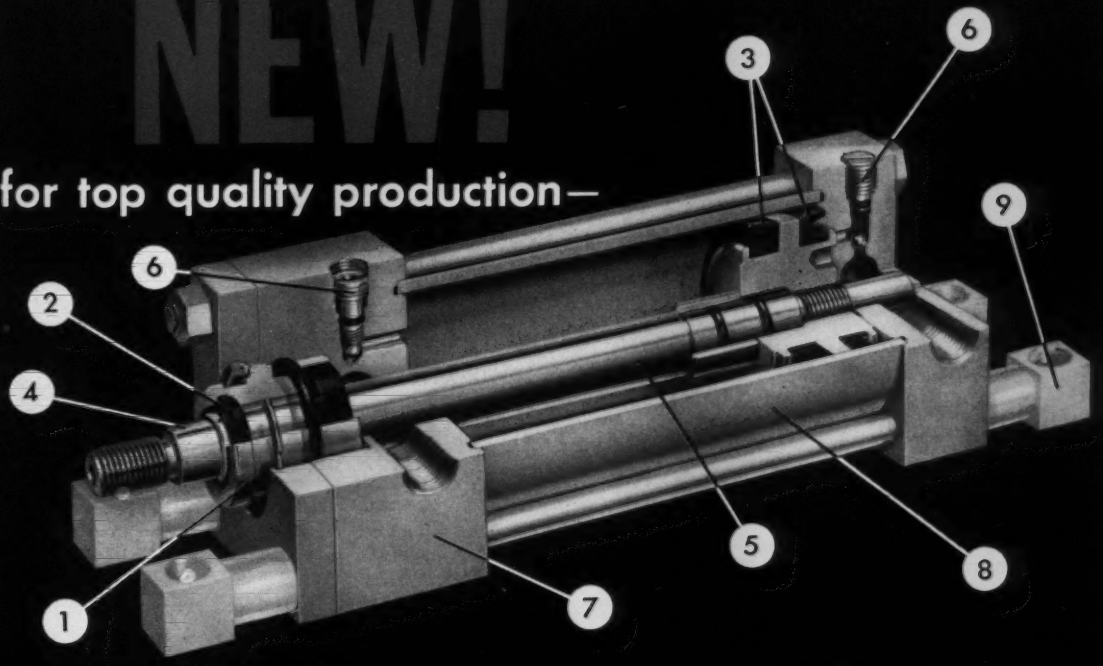
Item 419

A production rate of 425 pistons per hour is accomplished by special purpose milling machine that mills weight bosses on pistons. By means of interchangeable tooling, two different diameter pistons can be accommodated. Automatic cycle of the machine includes loading, orienting, clamping, milling, clearing the chips, and unloading. Features of the unit include: Automatic lubrication system, a fine adjustment for cutter depth, and preloaded bearings for the milling spindle that are adjustable to take up end play.

In operation, pistons are accepted dome down through a loading gate which permits one part at a time to enter a loading mechanism. The loader moves the piston into orienting jaws which align the part with an orienting head. The orienting head rotates the part, using opposing probes in the wrist pin holes. Circular jaws, combined with clamping fingers through the wrist pin holes, hold the piston firmly against a locating seat. The oriented and clamped piston is then moved through the milling, blow-out, and unload stations by a trap

NEW!

for top quality production—



1. Bronze Bearing, with self-adjusting "U" Cup Piston Rod Seal for longer wear.
2. Rod Wiper protects Piston Rod Seal and keeps Cylinder clean.
3. "U" Cup Seals expand with pressure to provide positive seal with minimum friction.
4. Wrench Flats make for easy installation.
5. Ground, hard chrome-plated Piston Rods have minimum yield strength of 125,000 psi.
6. Self-locking cushion adjusting screw and ball check are below surface for protection . . . easily accessible.
7. For extra strength, Cylinder Ends and Mounting Plates are machined from bar stock and steel forgings.
8. Cylinder is precision-finished brass for extra heavy duty.
9. Variety of mountings can be interchanged—easily match any installation requirement.
10. Interchangeable with all JIC Cylinders.

SCHRADER SQUARE-END CYLINDERS

meet and exceed JIC specs . . . 250 psi air . . . 750 psi hydraulic!

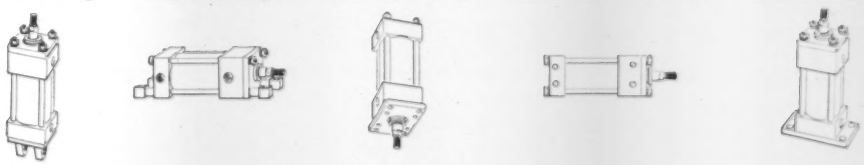
Here's compact, versatile straight-line power. Just look at the features!

Use Schrader's new square-end double-acting cylinders for holding, positioning, moving work—for push, pull or lifting—for automating manual operations. In five sizes up to 4-inch bore, and with five interchangeable mountings, these "square-ends" are economical and versatile. Bolt, leg, flush, side flush or base . . . each JIC Cylinder will mount all five ways. Suitable for air pressures to 250 psi, or hydraulically to 750 psi—available cushioned or non-cushioned.

You get safe, controlled, low-cost power with Schrader "square-ends"—another addition to the line of famous Schrader quality Air Control Products.

Complete stocks available locally—expert help to improve your air control hookups. Write for your complete specifications and data on these new "square-ends."

Bolt Mounting **Leg Mounting** **Flush Mounting** **Side-Flush Mounting** **Base Mounting**



Schrader® a division of SCOVILL

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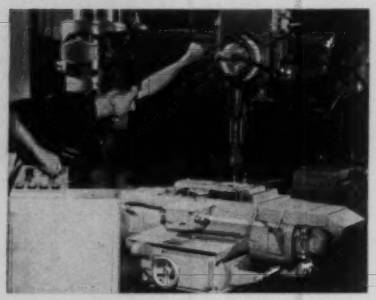
Division of Scovill Manufacturing Co.
472 Vanderbilt Avenue, Brooklyn 38, N. Y.

QUALITY AIR CONTROL PRODUCTS

Circle 684 on Page 17

type rotary transfer mechanism which prevents station override. **F. Jos. Lamb Co.**, 5663 E. Nine Mile Rd., Detroit 34, Mich.

Circle 419 on Page 17



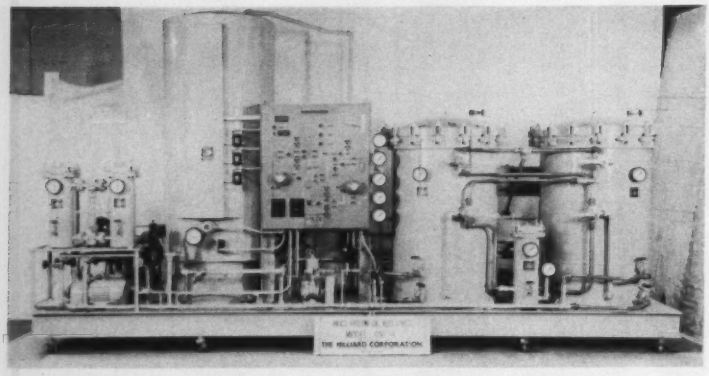
Positioning Table

Item 420

Steel tape-controlled, 2-axis, point-to-point positioning table is a self contained unit, can be used with any existing vertical spindle machine tool for repetitive drilling, reaming, and tapping jobs. Unit consists of the table and a control console which contains all programming and playback controls. Table has a 16 by 24 inch working surface and 14 by 18 inch travel. It traverses at a speed of 90 ipm with a 6 ipm approach speed. Position accuracy is ±0.001-inch. All functions are directed from the control console. Controls include: Indenters for marking tape for transverse and longitudinal movements, *Stop*, *Jog*, and *Run* operation buttons; signal lights to indicate when the drill head is in correct position; *Start* buttons for table motions; and *Direction Change* buttons.

The position program is carried on two stainless steel tapes, one for each axis of the table. The tapes are marked either according to readings on an accumulator mechanism or by mounting a master part on the worktable and moving the table into the required positions. In operation, one tape controls transverse movements of the worktable and the other controls longitudinal movements. These movements of the table are controlled by a clutch-brake which starts and stops lead screws as switches sense the markings on the tapes. The tapes are re-usable. **Industrial Controls Div., Topp Industries Inc.**, 5221 W. 102nd St., Los Angeles 45, Calif.

Circle 420 on Page 17

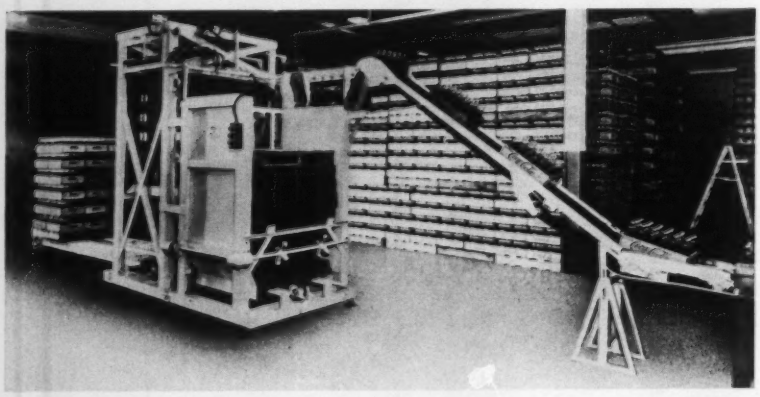


Vacuum Pump Oil Reclaiming System

Item 421

Equipment is designed for full-flow purification of lubricating and sealing oil for high vacuum pumps. It is capable of delivering 600 gph of vacuum pump lubricating and sealing oil, with a total oil circulating rate of 500 gph. Model 600-X is equipped with duplex inlet strainers to protect pumps, inlet and outlet pumps, an electrically heated vacuum vaporizer with three banks of thermostatically controlled heaters, and duplex fuller's earth filters in the outlet line. The filters can be operated either in parallel or individually. Other features of the reclaimer include: Centrally located graphic control panel with automatic electrical controls and alarm; and an automatic recirculation system on the vaporizer which will permit only dry, purified oil to be delivered to the vacuum pump charging system. **Hilliard Corp.**, Elmira, N. Y.

Circle 421 on Page 17

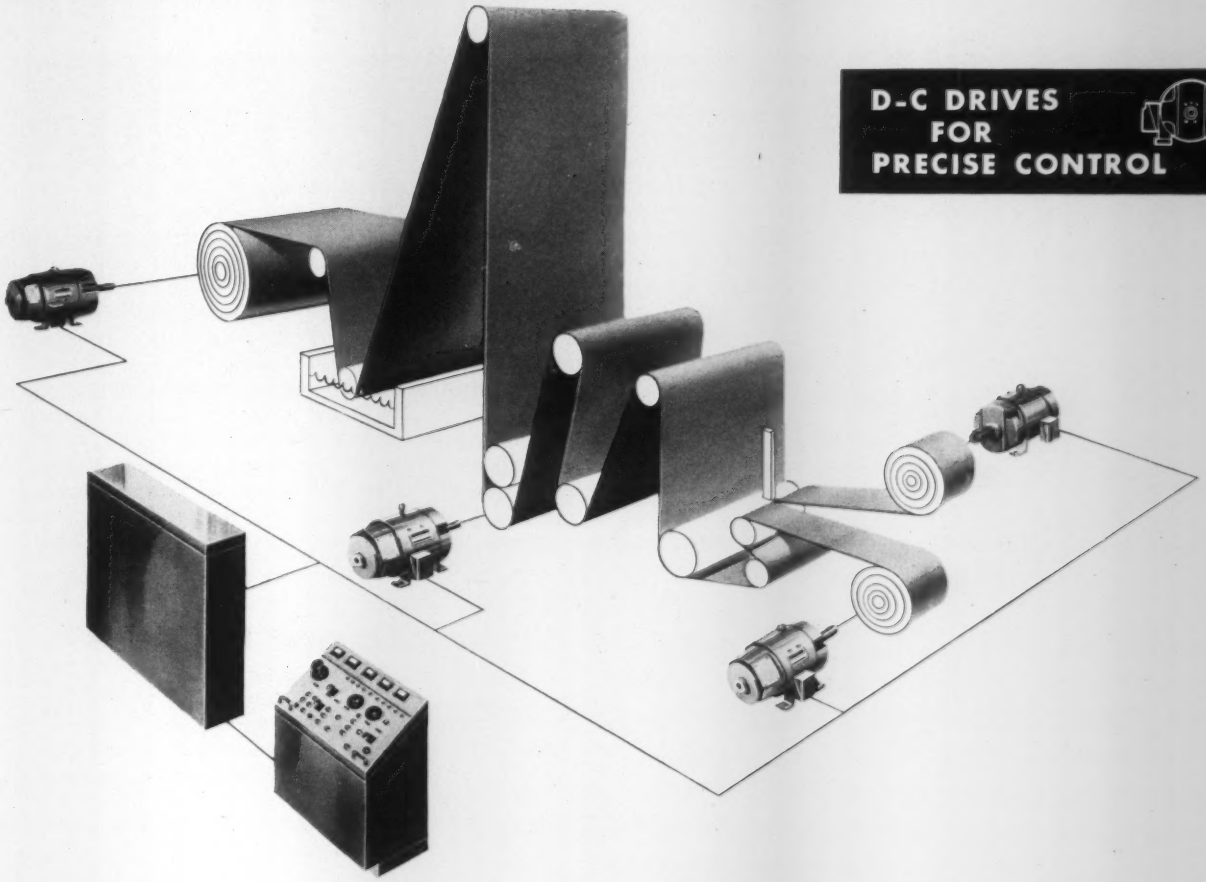


Pallet Loader Stacks Beverage Cases Automatically

Item 422

Air-operated equipment can automatically stack up to thirty filled beverage cases per minute on pallets. Machine has electrical controls which are operated by pushbutton. It will operate continuously if the loaded pallets are removed from the discharge point and the magazine is supplied with empty pallets. The loader can also be stopped and restarted at any time during the loading cycle.

The magazine can hold up to twelve empty pallets. In operation, cases or cartons of bottles are conveyed up an inclined belt to the loader and are positioned in pairs. An air-operated rake pushes them in position, then repeats the process until a complete layer has been assembled. When a layer is completed, drop gates open automatically and lower the load onto a waiting pallet. The pallet is lowered to receive each layer, and the pallet and full load are removed by a powered con-



D-C DRIVES FOR PRECISE CONTROL

Problem: How to control sheet or web tensions for faster machine operation, better quality

Tension inaccuracies during high speed production can result in torn sheet, costly production snarls, poor product quality. To control sheet or web tensions accurately, speeds of machines must be closely synchronized. Equipment must be brought up to top speed gradually—smoothly—without loss of tension. Often a dozen motors must respond as one—instantly. **Direct-current drives can best meet this need.**

In continuous processing—wherever accurate control is needed—direct-current adjustable-speed drives perform with instantaneous tension adjustment—smoothly, automatically. The result: faster machine operation, better quality, lower production cost.

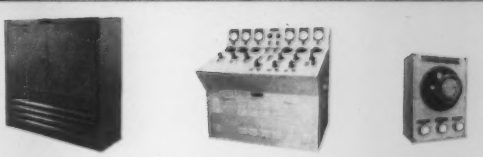
This is only one example of d-c's modern capabilities. Throughout industry there is a growing trend to more direct-current powered equipment. The reasons for this trend are explained in a new General Electric booklet called "WHY D-C?" For your free copy, write *Department 829-1, General Electric Co., Schenectady 5, New York.*

Progress Is Our Most Important Product

GENERAL ELECTRIC

SELECT FROM G.E.'S COMPLETE LINE OF D-C DRIVES

MOTORS AND GENERATORS

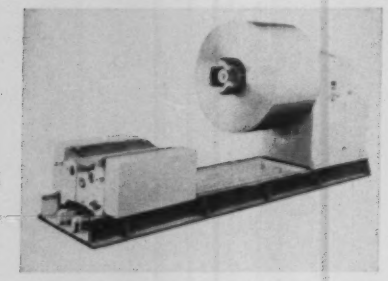


POWER UNITS AND CONTROLS

Circle 685 on Page 17

veyor. The machine can be preset to stack four, five, six, or seven cases high. **Radio Corp. of America,** 30 Rockefeller Plaza, New York 20, N. Y.

Circle 422 on Page 17

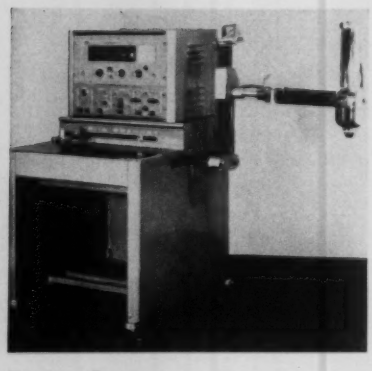


Coil Stock Handler

Item 423

Combination motor-driven reel and loading car can handle heavy coils of steel and tin plate. The reel can take coils up to 15,000 lb with 54 inch maximum OD and 36 inch maximum width. Collapsible arms expand from 14½ to 17½ inches to grip the coil ID. In operation, the loading car holding the coil raises it to proper height for alignment with the axis of the reel spindle. The car then moves on tracks toward the collapsed arms of the reel. When the coil is in position, the three arms of the reel expand hydraulically to center the reel and the loading car is removed. **F. J. Littell Machine Co.,** 4101 N. Ravenswood Ave., Chicago 13, Ill.

Circle 423 on Page 17

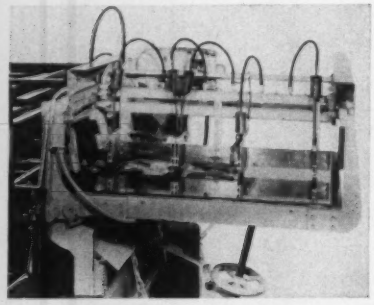


Data Scanner

Item 424

Instrument is applicable in field plotting, film scanning, gaging, three dimensional chromatograph scanning, and other measurement, control, or data reduction problems. Unit can scan in either a horizontal or a vertical plane. A desk height plotting table with printing stylus provides printed readout spatially distributed in conformance with detector or transducer position. The automatic scanning pattern is normally rectilinear; X axis scanning motion is continuous; Y and Z motions are normally step-wise with spacing as required to give desired resolution. All three motions in a rectangular coordinate system are motor driven. Scanner is equipped with a rack and panel type cabinet to house electronic equipment. **Ato-Mation Inc.,** 5959 S. Hoover St., Los Angeles 44, Calif.

Circle 424 on Page 17



Vacuum Forming Packager

Item 425

Automatic skin packaging or blister and vacuum forming machine has dual loading stations. Rapid indexing of platens permits high speed production. Some of the automatic functions of the machine are: Placement of the product being packaged, conveying of products to the skin application area, loading and unloading of plastic film, and slitting of packages to size. In operation, the products are placed on cards in the machine and the packaging cycle is started. A clamped film of plastic is heated and draped over the products as a vacuum is applied. At the end of the molding cycle the clamping frame is opened, permitting automatic unloading of the molding area. As the skin packaged card is removed from the molding area, it is slit lengthwise and cross cut.

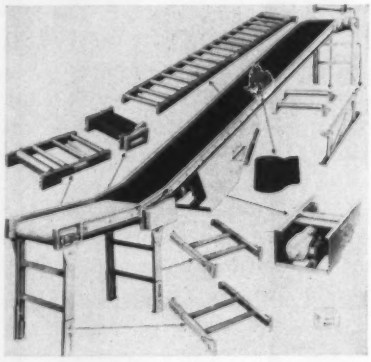
Electronic controls maintain the accuracy of slitting packages to size. The cross cutter is electrically operated to cut the packages to proper width. On the return stroke, the cutting table is swept clean for the next cycle. Slitters can be adjusted from ½ inch to the maximum size of the unit. Plastics up to 0.020 of an inch in thickness can be cut, and products up to six inches in height can be handled. Machine is available in two styles. Model 22 has a mold area of 22 by 30 inches, depth of drape or draw of 6 inches, and a dry cycle of 12 per minute. Model 23 has a mold area of 24 by 36 inches, depth of drape of draw of 6 inches, and a dry cycle of 10 per minute. **Comet Industries,** 9865 Franklin Ave., Franklin Park, Ill.

Circle 425 on Page 17

Conveyor Components

Item 426

Line of standardized belt conveyor components can be easily assembled without special training. Units can be arranged to provide continuous-flow interfloor transportation of parts and products, to act as a booster between gravity conveyor lines, or to serve as moving assembly lines. Components in the line include: Straight intermediate sections, top curves, feeder sections, drives, take-ups, belts, idlers,



floor supports, and ceiling hangers. The units can be erected in level, inclining, or declining positions. Side frames are designed so the bed rollers can be set either high or low. Reversible end and center drives are available in a range of horsepower ratings. Belt widths are furnished in 10, 14, 18, or 22 inches. **Alvey-Ferguson Co.,** 3011 Disney St., Cincinnati 9, Ohio.

Circle 426 on Page 17

Cylinders need not be expendable

With Extras . . . At No Extra Cost

1. METAL PISTON ROD SCRAPER—protects rod packing, cylinder bore and rod surface by removing all foreign particles.
2. NEW "SUPER" CUSHION for air or METALLIC SELF-ALIGNING MASTER CUSHION for oil.
3. HARD CHROME PLATED CYLINDER BORES AND PISTON RODS for greater protection and reduced wear.
4. ONE PIECE PISTON assures better alignment, longer bearing and packing life.
5. FORGED SOLID STEEL HEADS throughout entire line.
6. PILOTED PACKING GLAND with extra long bearing for additional strength and support to piston rod.
7. NO TIE-RODS TO STRETCH—gives you 360° port rotation . . . less space used . . . full strength.
8. STREAMLINED DESIGN . . . operating pressures to 200 PSI, air; 1,000 PSI oil, non-shock.

Specify the

T-J Spacemaker

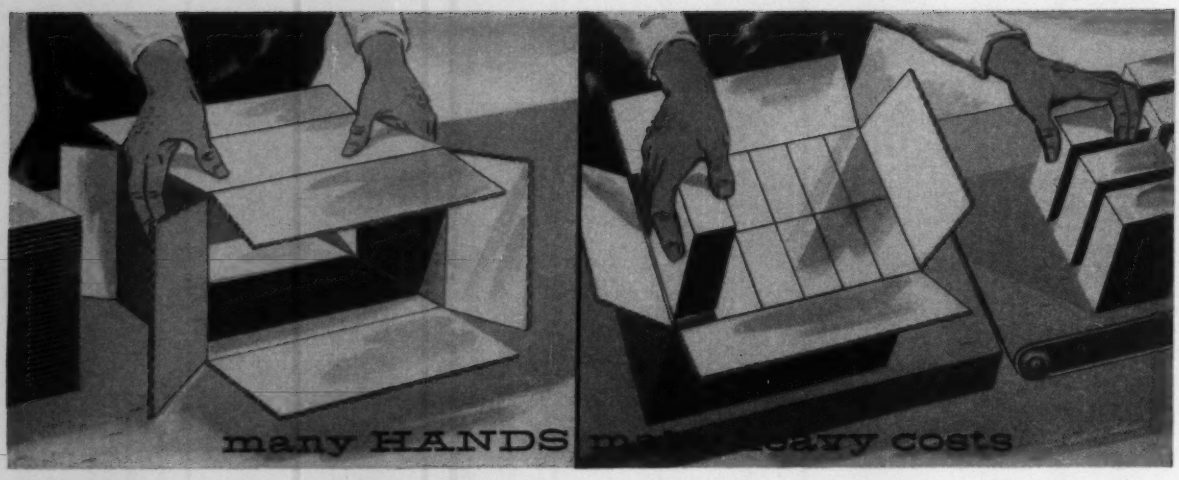
for longer, more efficient cylinder service

You too—can reduce replacement expenditures—lower maintenance costs with the T-J Spacemaker cylinder line. Designed and engineered for ruggedness, and accuracy of operation, the Spacemaker assures longer, uninterrupted operation.

The T-J Spacemaker eliminates tie-rods, gives greater strength, saves space . . . and reduces costs in all push-pull operations. Immediate delivery in a complete range of styles and capacities . . . air or oil. Write for Bulletin SM 155-4, today. The Tomkins-Johnson Company, Jackson, Michigan.

T-J TOMKINS-JOHNSON
RIVITORS . . . AIR AND HYDRAULIC CYLINDERS . . . CUTTERS . . . CLINCHORS

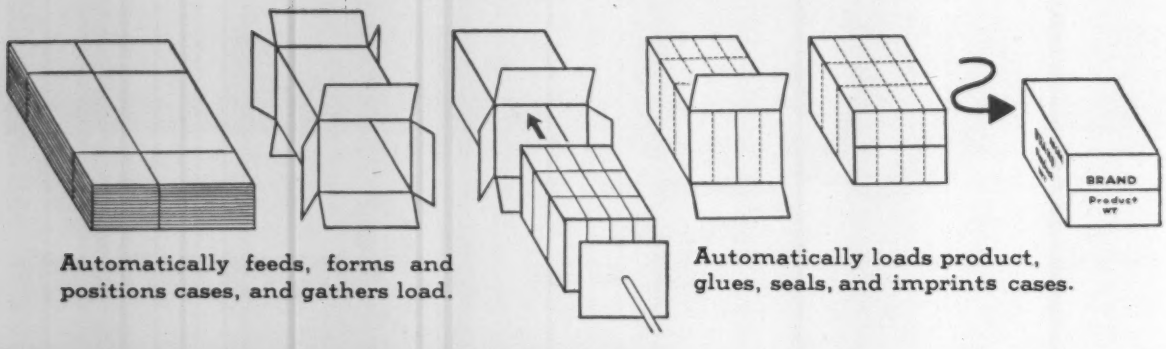
Circle 686 on Page 17



let Packomatic®
T.M. Reg. U. S. Pat. Off.

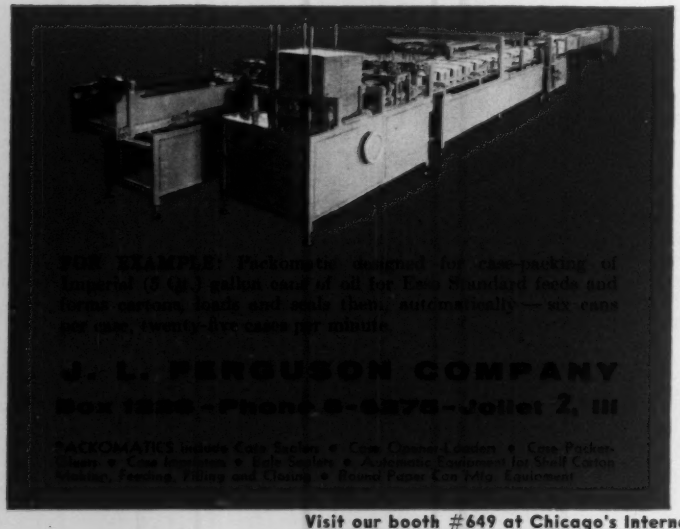
equipment do any or all your casing operations

AUTOMATICALLY



Automatically feeds, forms and positions cases, and gathers load.

Automatically loads product, glues, seals, and imprints cases.



For casing round, square, rectangular or free-form packages of virtually any size

You need not be a **big** company to enjoy the economies of Packomatic equipment. If your volume requires even one person to hand-form cases, hand-fill, hand-seal, or hand-imprint them, then a Packomatic machine can be a sound investment. Only a minute or two of attention at infrequent intervals is needed even for a **complete** automated Packomatic **line,** capable of matching the output of a dozen pair of hands. And in addition to reducing direct labor production costs Packomatic can, by utilizing end-opening shipping cases, reduce your paper-board costs up to 25%. And mechanically end loaded cases are stronger because the flaps give added resistance to weight and shock. In addition they stack better because their uniformly flat sides enables keying of pallet loads. Write, wire or phone us for facts on how to reduce your case packing costs.

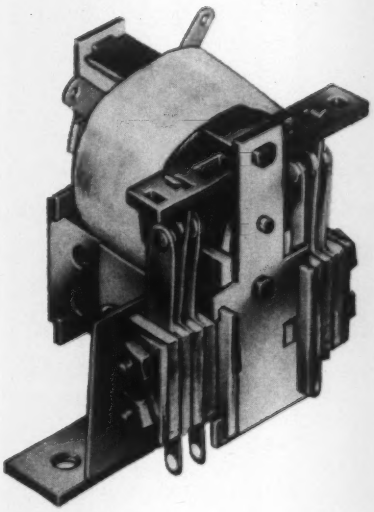
Visit our booth #649 at Chicago's International Amphitheatre

Circle 687 on Page 17

AUTOMATION new components

Parts, elements and devices designed for creating more automatic systems.

For detailed information and literature, use card page 17.



Bistable Relay With Magnetic Detenting

Item 427

POLARIZED, bistable relay features magnetic detenting. A permanent magnet provides a magnetic field to hold the relay in either one of its two normal positions, without holding current or mechanical latching. Relay is offered by **American-Monarch Corp.**, 2801 37th Ave., NE, Minneapolis 18, Minn. It can be used where continuous current drain or relay heating is to be avoided, where high vibration and shock are present, for polarity discrimination and reverse current protection, and as a binary memory unit.

The relay coil is positioned coaxially with the rocking armature. This armature serves as a keeper across the permanent magnet when the relay is in either one of its two normal positions. When a momentary electrical input establishes a field in the armature which opposes the permanent magnet field, the armature is rotated to its other position, causing the relay to instantly change positions. If the momentary input establishes an aiding field, the armature is not affected and the relay remains in its existing position.

Using a 13-ohm coil, a typical relay provides contact transfer in 8 milliseconds on 12 v dc, or 4 milliseconds on 25 v dc. It operates reliably on the discharge current from a 3 microfarad condenser charged to 120 v dc. A relay with a 100-ohm coil operates in 8 milliseconds on 30 v dc, or 3 milliseconds on 110 v dc. Voltage range of coils available is from 1.0 to 115 volts ac or dc with resistances from 0.5 to 5,000 ohms. Four single pole double throw contacts are available as standard; rated 2 amp, 24 v dc and 115 v ac; or 5 amp at 24 v ac.

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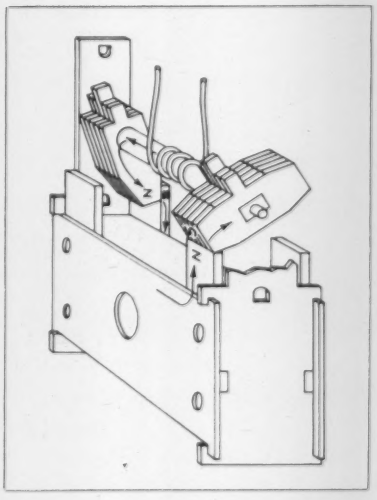

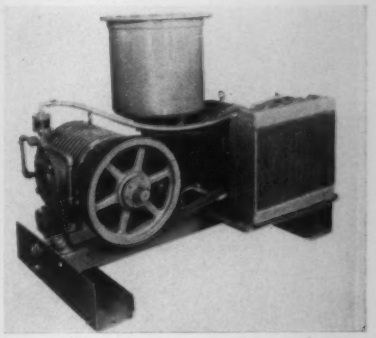

High Vacuum Pump

Item 428

Model 106 has six sets of dual vanes to provide positive high-pressure oil seal. Pump can provide a steady vacuum of 29.9 inches Hg in continuous operation at an average temperature of 200 F, with a capacity of 50 to 105 cfm. The balanced rotor is divided into six slots, each slot equipped with two independent steel vane sections, separated by a high pressure oil film which is forced outward between the vanes to the cylinder wall during rotation to assure a constant oil seal between the dual vanes and positive lubrication of the cylinder wall. The dual vanes provide two contact surfaces on the cylinder wall to seal off the low and high pressure side of the pump. The use of six dual vanes divides the high-pressure air pulsations into many small pulsations, providing an even flow of air and giving less vibration. The pump is cooled by a radiator-cooled lubricating system. The oil is constantly recirculated and cooled for passage through the pump. Lower-temperature operation permits speeds up to 800 rpm, maintains oil viscosity

Over 200 Electropunches now in use at KODAK!

For speed, efficiency, and economy, Eastman Kodak Co. uses over 200 Electropunches and Electrostakes for multiple staking and riveting operations on camera components. Here are 8 good reasons why:

- **Lightning speed** — .025 of a second operating cycle
- **Controlled impact** — from feather touch to 10,000 lbs.
- **Effortless operation** — a touch of hand or foot
- **Versatile** — for staking, riveting, crimping, swaging, marking, etc.
- **Mobile** — all-electric, plug into any 115V line
- **Save money** — economical price, operating cost
- **Save space** — occupy less than square foot of bench space
- **Save maintenance** — just two moving parts

Electropunches: In 4 Models designed to do staking jobs with ease and economy.

Send for free 12-page catalog describing our complete line of production tools and accessories.

BLACK & WEBSTER, INC.

Dept. 2, 445 Watertown St., Newton, Mass.

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for maximum lubricating properties, prevents carbonization of oil, and eliminates the oil vapor. **Leiman Bros.**, 102 Christie St., Newark 5, N. J.

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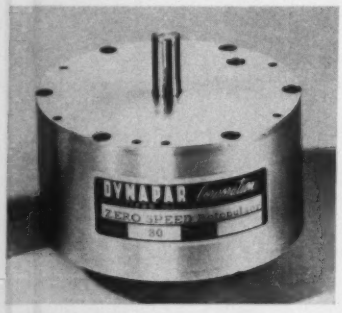
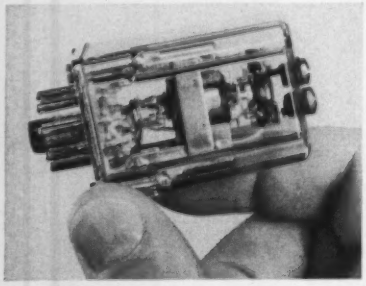


Shaft Rotation Counter

Item 429

Device is applicable to continuous process measurements for length, rpm, linear or angular position, belt speed, motor slip, or any physical quantity which can be converted into shaft rotations. The rotating shaft pulse counter can generate up to 1200 counts per revolution and can measure length down to 0.01-inch increments with a counting wheel 12 inches in circumference. Operating speeds can range above 10,000 rpm, with constant output at all speeds. The transistorized circuitry can be mounted in a separate power transformer case to extend temperature ranges. The unit can be used 100 ft away from the control equipment without a loss of reliability or accuracy. **Dynapar Corp.**, 5150 Church St., Skokie, Ill.

Circle 429 on Page 17



Meter-Relay

Item 430

Non-indicating meter-relay is enclosed in a clear plastic case, has good resistance to shock and vibration. Model 137 will trigger control action on signal changes as small as 0.2 microampere, or 0.1 mv dc. A rectifier is used for control from ac signals. Control begins when a contact on the signal pointer touches another on a limit pointer. A separate locking coil increases the contact pressure. **Assembly Products Inc.**, Chesterland, Ohio.

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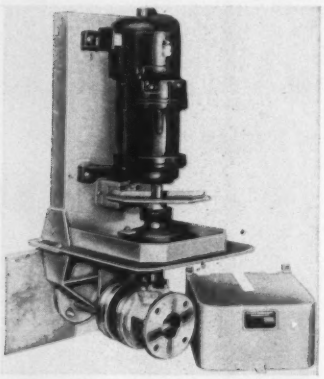

Heavy-Duty Water Valve

Item 431

Designed for remote control operation, motor driven water valve (shown with cover removed) features a fail-safe mechanism which automatically closes the valve when a power failure occurs. Unit can be installed in either a horizontal or vertical water line; is constructed to provide continuous service under rugged conditions. Opening and closing of the valve is accomplished by a built-in electric motor.

The valve has a resilient synthetic rubber seat that helps the floating ball to form a positive seal. The ball in combination with the seat allows abrasive particles to be automatically wiped clean of the seating surface without causing injury to the ball or seat. When the valve is closed, the pressure of the water will position the ball firmly against the seat forming a positive seal that stays tight even after numerous repeated operations. Unit is available in two sizes—Model MV-1000 is for 3-inch pipe and Model MV-2000 is for 4-inch pipe. **Gemco Inc.**, P. O. Drawer 3908, Shaker Square Station, Cleveland 20, Ohio.

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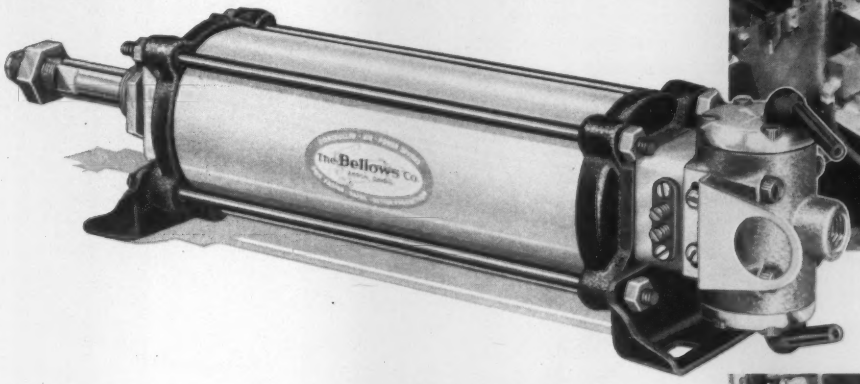
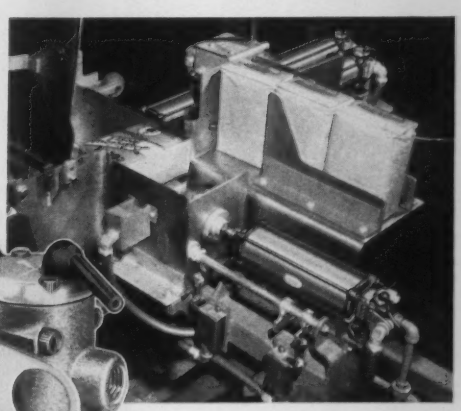
with the

BELLOWS AIR MOTOR®

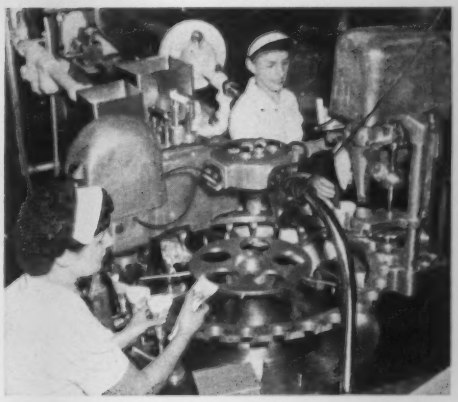




Packaging coffee is simplified by this Bellows Air Motor powered equipment.

...you can build special machines ...or modernize existing machines *at low cost and quickly!*

With parts normally available in every tool room, plus one or more Bellows Air Motors, and a little creative ingenuity, you can "spot modernize" scores of operations whose high cost whittles away at profits. The few illustrated here are typical of hundreds we can show you. The chances are good that no matter what you make, nor how you make it, this versatile air cylinder, with its *built-in* electrically controlled valve, can lend a mighty important helping hand to your cost reduction program.

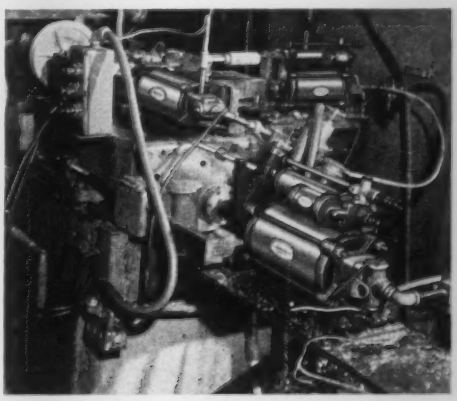


Bellows Air Motors fill ice cream, add nuts and fudge, fold and seal the wrapper in this special machine.

THIS FREE "SPOT-A-MATION FILE" MAY SPARK AN IDEA IN YOUR MIND THAT CAN MEAN IMPORTANT COST SAVINGS

A note on your letterhead addressed to Dept. AU459, The Bellows Co., Akron 9, Ohio, will bring you basic data: wiring diagrams, installation details, equipment list, on a score of "everyday" operations almost every industry uses—and, if you wish, the services of a Bellows Field Engineer, to help you adapt those ideas to your specific needs.

1313-B



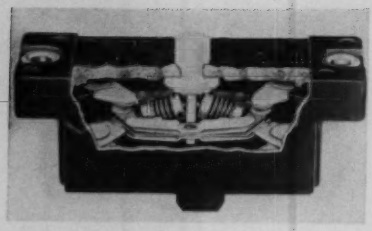
Tail stock, tool bit, and cross-slide are moved by Bellows Air Motors in this lathe conversion.

The Bellows Co.

DIVISION OF INTERNATIONAL BASIC ECONOMY CORPORATION (IBEC)

AKRON 9, OHIO

OTHER INDUSTRIAL DIVISIONS OF IBEC: Sinclair-Collins Valve Co., Valvair, Akron, Ohio • V. D. Anderson Co., Cleveland, Ohio



Limit Switch

Item 432

Feature of this precision limit switch is the contact mechanism which is designed to extend electrical and mechanical life and provide dependable operation. The mechanism incorporates a movable contact assembly utilizing two compressed coil springs to provide quick make and break actions. A leaf spring carrying the contacts provides adequate contact pressure at all times, and eleminates any points of zero contact pressure. Switch has an electrical rating of 600 v, ac or dc, breaks up to 15 amp and makes up to 40 amp at 110 v. Unit is enclosed in a semidust-tight molded phenolic case. A variety of operators (such as plunger, roller, and cabinet door types) is available for use in combination with the basic switch. **Cutler-Hammer Inc.**, 378 N. 12th St., Milwaukee 1, Wis.

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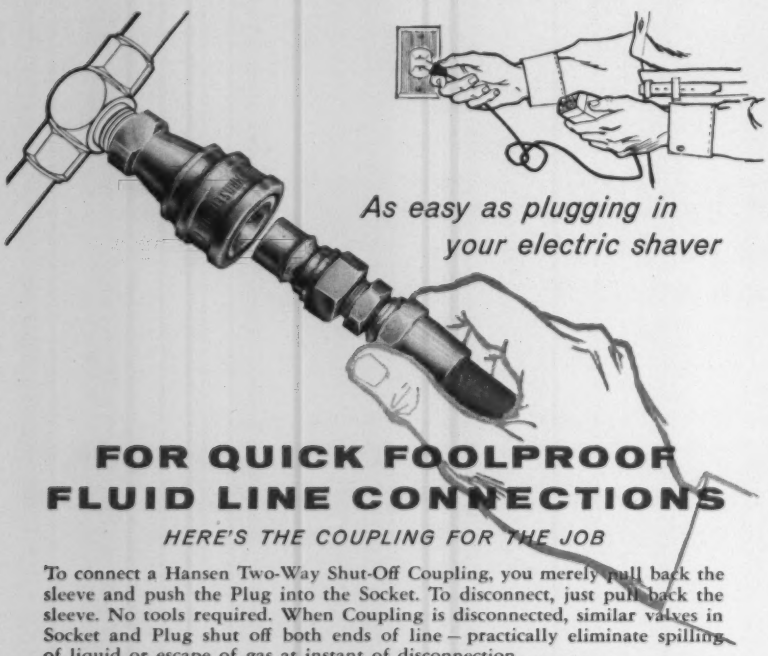


FOR QUICK FOOLPROOF FLUID LINE CONNECTIONS

HERE'S THE COUPLING FOR THE JOB

To connect a Hansen Two-Way Shut-Off Coupling, you merely pull back the sleeve and push the Plug into the Socket. To disconnect, just pull back the sleeve. No tools required. When Coupling is disconnected, similar valves in Socket and Plug shut off both ends of line – practically eliminate spilling of liquid or escape of gas at instant of disconnection.

Hansen Series HK Two-Way Shut-Off Couplings are available with female pipe thread connections from ⅛" to 1" inclusive. Available in brass or steel.

WRITE FOR THE HANSEN CATALOG

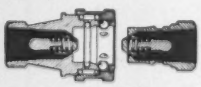
Here's an always ready reference when you want information on couplings in a hurry. Lists complete range of sizes and types of Hansen Quick-Connective Couplings. Write for your copy.

HANSEN

SERIES HK®

TWO-WAY SHUT-OFF COUPLING

Instantly shuts off both sides of line . . . prevents loss of liquid, gas, or pressure.



QUICK-CONNECTIVE FLUID LINE COUPLINGS

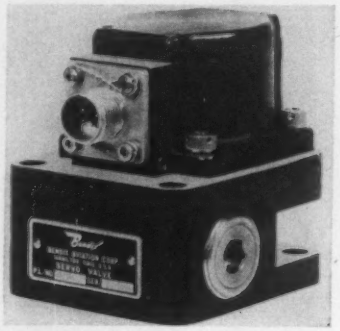
FOR COMPRESSED AIR • HYDRAULIC FLUIDS • OIL • GREASE
WATER • VACUUM • STEAM • OXYGEN • ACETYLENE
REFRIGERANTS • GASOLINE • COOLANTS • LP-GAS

REPRESENTATIVES IN PRINCIPAL CITIES

SINCE 1915 — **QUICK-CONNECTIVE FLUID LINE COUPLINGS**

THE HANSEN MANUFACTURING COMPANY

4031 WEST 150th STREET • CLEVELAND 35, OHIO

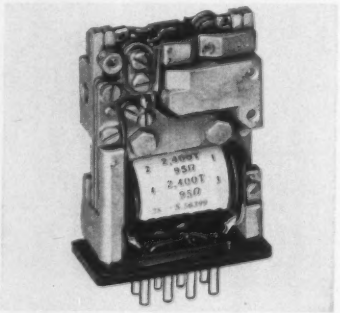


Servo Valve

Item 433

Electrohydraulic, closed loop servo valve features a high reliability and fast response for fluid power drives of numerical and template controlled machine tools. Model A27 has a rated flow of 6 gpm, is applicable to any electrohydraulic servo control system operating up to 3000 psi. **Hamilton Div., Bendix Aviation Corp.**, Fifth St. & Ford Blvd., Hamilton, Ohio.

Circle 433 on Page 17

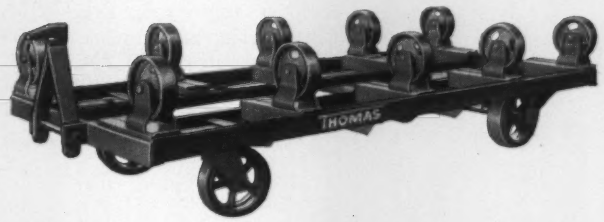


Polarized Relay

Item 434

Unit is capable of producing a square-wave output from weak input signals. It is suitable for use in electronic controls, in supervisory circuit monitoring, in servomechanisms, or in bridge circuits as a null-sensing device without amplifiers. Relay, designated Type 51, is said to have a life of one million

SOME THOMAS "Job-Suited" TRUCKS LOOK VERY PECULIAR



This Thomas No. 396 Trailer was "Job-Suited" with inverted rigid casters welded opposite each other, on each side of the trailer so that the larger steel drums being carried could be rotated while in transport.

BUT . . . that's because they're Designed to Handle Special Jobs Faster, More Economically

Thomas builds hundreds of trucks to carry loads up to 50 tons and to work with all the latest powered equipment. Any one of these trucks can be "Job-Suited" with standard superstructures designed and built to hold your particular loads. An out-of-the-ordinary superstructure may speed up loading and unloading, carry your loads safely—save time, manpower and materials . . . actually save many times its cost.

For extremely unusual or difficult handling, the Thomas engineering department can design and build special equipment to meet your specific requirements.

Endless variations for shelf trucks.

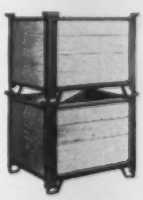
Combination dolly and live skid for lift truck use.

All types and capacities of casters and wheels.

"Power-Suited" all-duty trailers, 1,000 to 10,000 lbs.

Replaceable flush top skid platforms.

Platform for use with both Jack and lift trucks.

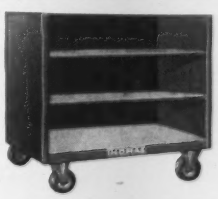


Economical multiple-storage stacking boxes

Safety one-man drum truck

Adapted for overhead and underfloor towing.

Puts parts at machine height.



Elevated three-sided panel truck.

Rack truck for parts or tote pans.

A Thomas Representative . . .

is ready to help solve your handling problems. Write for your free catalog describing the complete line of Thomas "Job-Suited" Trailers, Trucks, Casters, Wheels and "Jak-Tung" Systems.

Only THOMAS Makes "Job-Suited" Trucks

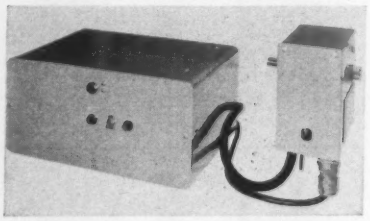
THOMAS TRUCK & CASTER CO.
920 Mississippi River
Keokuk, Iowa

Circle 691 on Page 17

increase
equipment
reliability
...with RCA
"Premium" and
"Special Red" Tubes
Recommended for industrial electronic equipment where standard receiving-type tubes are now used. Specially designed, manufactured, and tested to give long and dependable performance. Available at all RCA Industrial Tube Distributors.
Handy data book RIT-104-A includes tube characteristics to help you select the correct RCA "Premium" and "Special Red" Tubes for your critical industrial applications. Free, from your RCA Industrial Tube Distributor or write to RCA, Commercial Engineering, Section D-85-Z, Harrison, N. J.
RADIO CORPORATION OF AMERICA
Electron Tube Division
Harrison, N. J.
For the name of your nearest RCA Industrial Tube Distributor, call Western Union by 'phone number and ask for me, Operator 25.

response cycles without readjustment. It can withstand 4000 shocks at 40 G's and vibration from 10 cps at 0.04 inch to 150 cps at 0.006 inch, double amplitude. Unit has a thermal stability of from −40 to 70 C (±20 per cent performance change maximum). Relay is furnished in two styles—Type 51A is bistable, has a sensitivity of 2 to 5 amp-turns; Type 51M is centerstable, has a sensitivity of 1 to 3 amp-turns. **C. P. Clare & Co.**, 3101 Pratt Blvd., Chicago 45, Ill.

Circle 434 on Page 17



X-Ray Gage

Item 435

Low density material such as paper, fabrics, sheet, and film-like materials can be measured with new x-ray gage. The gage has a source that can be turned *On* and *Off*. When the gage is *Off* the source is *Off*. Use of this electronic gage does not require an AEC license or the maintenance of special laboratories. **X-Ray Dept., General Electric Co.**, 4855 W. Electric Ave., Milwaukee, Wis.

Circle 435 on Page 17

Rolling Conveyor Belt

Item 436

Woven metal conveyor belt is constructed for free rolling rather than sliding friction. Unit has built-in rollers which turn on the connector rod. The connector rod is positioned below the center line of the belt, and the roller face projects on the lower side of the belt only, where it provides rolling friction without interference to the pay load carried. Belt can also be used for turntable operation. In this use, the minimum recommended inside turning radius is 3 times the belt width. **Ashworth Bros. Inc.**, Winchester, Va.

Circle 436 on Page 17

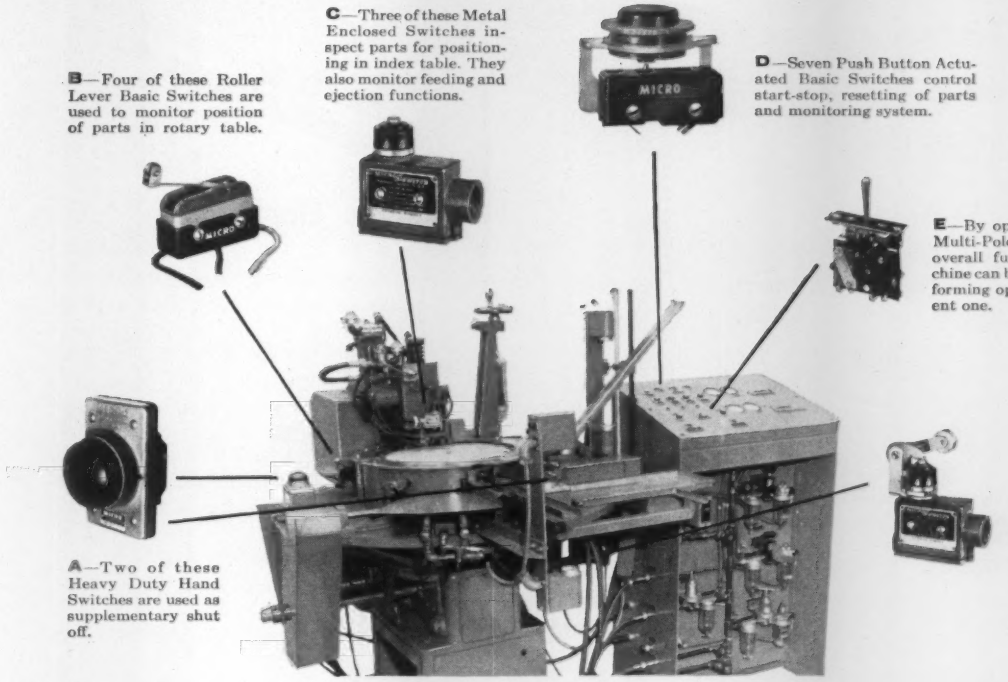
H HONEYWELL

MICRO SWITCH Precision Switches

C—Three of these Metal Enclosed Switches inspect parts for positioning in index table. They also monitor feeding and ejection functions.

D—Seven Push Button Actuated Basic Switches control start-stop, resetting of parts and monitoring system.

B—Four of these Roller Lever Basic Switches are used to monitor position of parts in rotary table.



E—By operation of this one Multi-Pole Toggle Switch, the overall function of the machine can be changed from one forming operation to a different one.

F—Eight of these Adjustable Roller Lever Enclosed Switches, in two banks, control forming operation, starting and stopping point of table, feeding, air cleaning and ejection of parts.

A—Two of these Heavy Duty Hand Switches are used as supplementary shut off.

One Operator per Week instead of Four

120 Man-hours Saved per Week

3000 Pieces per Hour instead of 1600

These remarkable savings are typical of those that can be affected on many machines by automating them with MICRO SWITCH Precision Switches.

In addition to the savings set forth above, this manufacturer of small, electrical products reports a total elimination of scrap parts and an additional saving of 175 hours per week in other departments.

Management in all types of business has accepted and proved the worth of this simple, inexpensive way to modernize existing equipment with MICRO SWITCH Precision Switches.

And, it *is* simple to do. Your own electrical maintenance men, cooperating with your plant engineering staff or with your local industrial electrical contractor, can do it.

We will venture to say that once you automate one machine in this way, you will soon apply MICRO SWITCH Precision Switches to other production tools in your plant.

Find out about this method of relieving the "profit squeeze" by contacting an authorized MICRO SWITCH distributor. You'll find his name in the Yellow Pages.

MICRO SWITCH . . . FREEPORT, ILLINOIS

A division of Honeywell

In Canada: Honeywell Controls, Ltd., Toronto 17, Ontario

H HONEYWELL **Honeywell**

MICRO SWITCH PRECISION SWITCHES

Circle 692 on Page 17

How did this lever system solve an age old weighing problem?

PROBLEM

SOLUTION

Early man was aware of the progressive inaccuracies of his pivot balance scales . . . but none knew how to remedy the situation.

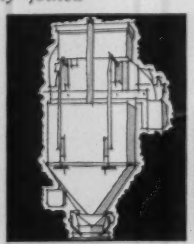
The problem was solved in 1956 when the United States issued a patent for a "Thayer Flexure Plate" Leverage System. A team of engineers and businessmen aware of industrys tremendous cumulative loss of materials in weighing operations, had devised a revolutionary new scale.

Knife-edge pivots that progressively wear and change were replaced by Thayer Flexure Plates that move only .001", yet accurately reflect the minutest changes in weight. This *firmly joined* lever withstands shocks and vibrations indefinitely. Dirt and dust are no longer a problem. Thayer guarantees this leverage system accurate for the life of the scale.

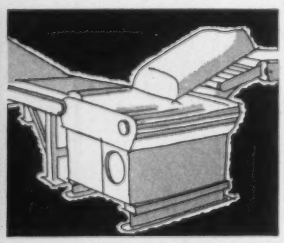
How Can It Save You Money Year After Year?

Working in conjunction with straight electrical controls, it forms the most reliable, low maintenance system ever devised to control processing or materials handling *by weight*. Literature on its application to filling, batching and checkweighing operations is available on request.

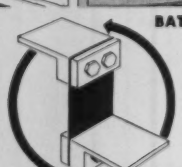
BATCHING



FILLING



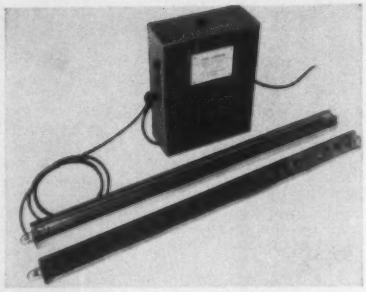
CHECKWEIGHING



THAYER SCALE

AUTOWEIGHTION SYSTEMS FOR FILLING, BATCHING AND CHECKWEIGHING

THAYER SCALE CORP. • 5 THAYER PARK, PEMBROKE, MASS.

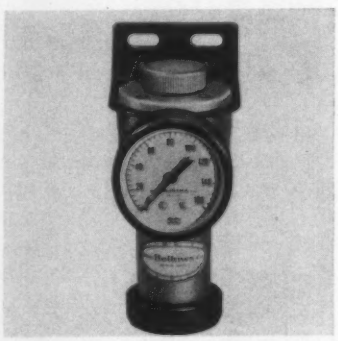


Static Eliminator

Item 437

Design of electrode shield on static eliminator features a full length slot which creates a continuous bar of ionized air to provide all yarn ends with equal relief. The static eliminator includes a power supply and three bar and head assemblies. The square shape of the shield permits the yarn sheet to come closer to the electrode head without damaging the yarn. The top surface of the shield is one continuous slot which extends the full length of the shield. The bottom, opposing surface, is perforated. This construction permits ionization to create an upward draft which increases the ion dispersion rate. The unit can be assembled with either the slot or the perforations directly under the yarn sheet. **Lindly & Co.**, 248 Herricks Rd., Mineola, N. Y.

Circle 437 on Page 17



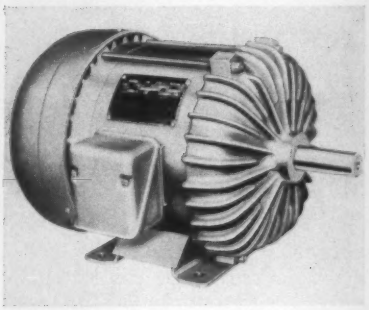
Air Line Regulator

Item 438

Device has a built-in pressure relief valve which allows increases in downstream pressure to bleed into the atmosphere when such pressure exceeds the regulator setting. The regulator knob adjusts the pressure by turning in one plane

of rotation. The primary line operating pressure of up to 250 psi can be reduced while maintaining downstream pressures of zero to 50 psi, zero to 125 psi, or zero to 250 psi. When maintenance is required, the replaceable chrome plated poppet valve stem can be removed from the regulator, and a new assembly inserted, without disturbing the air line. Regulator is available in 1/4 and 3/8-inch sizes. **Bellows Co.**, Akron 9, Ohio.

Circle 438 on Page 17



Single Phase Motor

Item 439

Line of single phase motors is constructed in totally-enclosed fan-cooled, or explosion-proof frames for installation in environments in damp areas, dusty or corrosive atmospheres, and out-of-doors. All metal parts have a rust and corrosion resistance coating. Motors are available in 2, 4, and 6 pole speeds with ratings ranging from 3/4 to 5 hp. Condensers and the centrifugal mechanism used on the motor are enclosed within the front end head for protective purposes. Unit is also equipped with double-width, prelubricated and sealed ball bearings. **Motor Div., Robbins & Myers Inc.**, Springfield, Ohio.

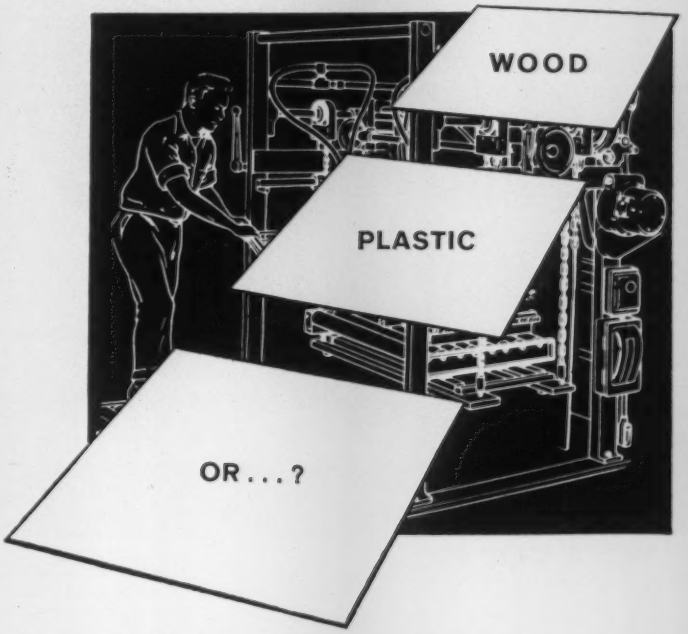
Circle 439 on Page 17

Magnetic Storage Drum

Item 440

Vertically mounted magnetic storage drum can store approximately 1,500,000 bits. Drum surface run-out is 0.0001-inch or less of total indicator reading. An induction type, integral motor is used and with variations of stator design, rpm's from 900 to 3600 can be provided. The drum is 10 inches in

If You Feed Flat Sheets of . . . METAL



Increase Production Line Efficiency with

DEXTER AUTOMATIC
FLAT SHEET FEEDERS

Hundreds of Dexter Flat Sheet Feeders are increasing production today in metal decorating plants, appliance firms, tin plate lines, and in stamping, slitting, cutting and trimming operations.

Dexter specializes in flat sheet feeding. There's probably a feeder to fit your requirements, for Dexter Automatic Flat Sheet Feeders handle all types of materials...metal, plastic, wood, masonite, glass and numerous others. They're built in over a hundred sizes, speeds, and load capacities ...sheet sizes range from 14 x 14 inches to 4 x 12 feet... thicknesses from .006 to 1/4"...capacities from 6000 to 30,000 lbs....and speeds from 600 to 9000 per hour.

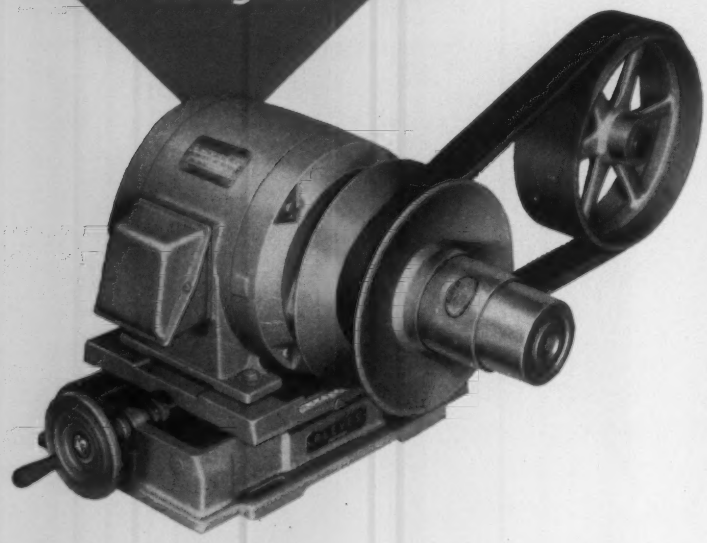
Investigate how Dexter Automatic Flat Sheet Feeders may improve your production efficiency. We'll be pleased to discuss your operation at no obligation, of course.

THE DEXTER COMPANY
A DIVISION OF MIEHLE-GOSS-DEXTER, INC.
CHICAGO 8, ILLINOIS

Designers of a full line of sheet handling equipment since 1880

Circle 694 on Page 17

completely redesigned



REEVES® *Vari-Speed MOTOR PULLEY*

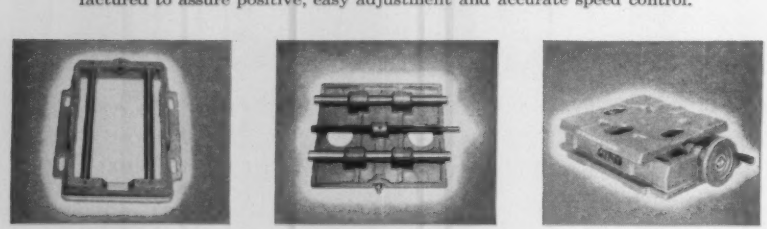
Here is variable speed control in its most simplified form . . . variable speed control with new economy.

Disc assemblies have just three main parts: two smooth-face, cone-shaped discs; and the belt tension spring. There are no other wearing parts to give maintenance trouble. Compact disc assemblies available in nine sizes, ½ hp. through 15 hp., to fit both old and new NEMA motors.

Separately mounted countershaft assemblies are available. For complete information on sizes and available controls, write for Bulletin AN36c-V582

Split section view of sliding disc shows how REEVES "close grooving" maintains film of lubricant between hub length of fixed disc and bore of sliding disc. One lubrication point services entire disc assembly.

New precision bases Four compact sizes to accommodate old and new NEMA motors in ½ through 15 hp. Sturdy bases are specially manufactured to assure positive, easy adjustment and accurate speed control.



Base and motor slide rods manufactured for precision fit and true alignment. Fully-lubricated shifting screw and precision features provide easy shifting.

REEVES PULLEY COMPANY

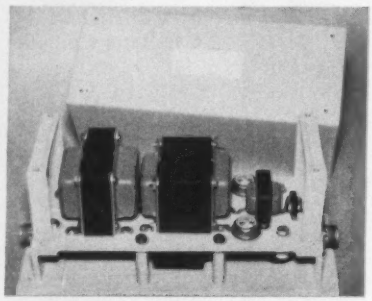
Division of **RELIANCE** ELECTRIC AND ENGINEERING CO.

Columbus, Indiana

Circle 695 on Page 17

diameter and 16 inches long. Recording surface of the drum is coated with a grindable magnetic oxide coating. The entire assembly is in a dust-tight exterior cabinet. **Bryant Chucking Grinder Co.**, Springfield, Vt.

Circle 440 on Page 17



Servo Amplifier

Item 441

Tubeless servo amplifier is designed for automatic control applications on machines or processes. Model AS-20 employs semiconductor circuitry, will operate in any 60 cps servo system. It receives input from a synchro control transformer and drives a 20 w servomotor. Electrical characteristics of the unit are: Input impedance, 20,000 ohms; output impedance (750 + j 250) ohms; voltage gain, 57; power gain, 50 db; over-all phase shift, less than 10 degrees; input voltage 2.0 v rms, up to 50 v rms without damage; output power, 20 w maximum. The amplifier will operate at full ratings from −55 to +55 C, in humidity of zero to 100 per cent at 55 C. **Di/An Controls Inc.**, 40 Leon St., Boston, Mass.

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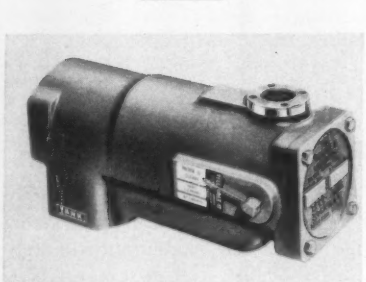


Dirt-Indicating Filter

Item 442

Suitable for filtering the inlet and outlet lines of hydraulic and metal

cutting coolant systems, filter can be used with pressures up to 400 psi. Device is furnished in two styles. A plain filter cartridge provides a rating of 30 gpm and a pleated surface filter cartridge provides a rating of 60 gpm. A needle indicates when the cartridge requires cleaning or, for remote signaling, indication is by electric switch. For the cleaning operation, only the end plate has to be removed. Filter is available in capacities of 5, 10, 20, 30, 50, 60, 75, 100, 150, and 200 gpm. **Rosaen Co.**, 1776 E. Nine Mile Rd., Hazel Park, Mich.

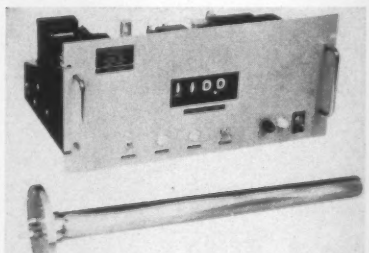
Circle 442 on Page 17

Hydraulic Fluids

Item 443

Line of synthetic fire-resistant hydraulic fluids can be used in heavy-duty installations involving radial-piston pumps and high pressures. The fluids are made in four different viscosities and two different types for high-pressure circuits and for installations with high fluid circulating temperatures. The development of this line in addition to the water-glycol type and water-emulsion type fluids already available provides hydraulic fluids for all types of equipment and services. **Lubricating Dept., Socony Mobil Oil Co. Inc.**, 150 E. 42nd St., New York 17, N. Y.

Circle 443 on Page 17



Liquid Level Gage

Item 444

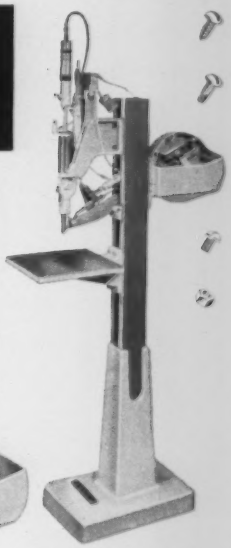
Instrument can make continuous level measurements for a wide range of electrically conductive liquids and granular solids such as kerosene, liquid oxygen, water, nitric acid, and grain. Model 0358-1 operates from 115 v, 60 cps power, uses a capacitance circuit which requires no moving mechanism in the material being measured. The height of the material produces a change in capacitance which is measured by a self-balancing bridge so that the readout is the shaft rotation of the servo rebalance. The readout can be in dial or counter form (shown), or it can be built into an 11-inch strip chart recorder.

The gaging method is adaptable to different arrangements. It is possible to connect a number of probes in parallel and gage both the total of all tanks as well as the contents of each tank. A density or temperature measurement can be taken simultaneously and inserted in the circuit to produce an accurate weight reading. The gage can also be set up with an automatic selector switch to make a series of measurements, and by the use of a shaft encoder, a continuous log of the readings can be printed out. **Magnetic Instruments Co. Inc.**, 546 Commerce St., Thornwood, N. Y.

Circle 444 on Page 17

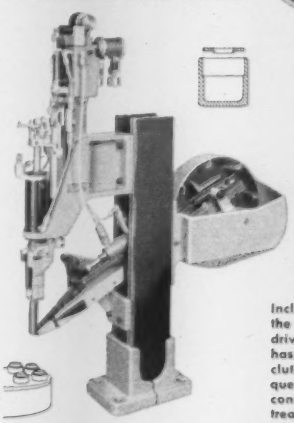
DIXON AUTOMATIC ASSEMBLY EQUIPMENT

For fast, accurate assembly of small parts, DIXON has developed two types of equipment: *Auto-Positioners* for automatic assembly work and *Auto-Torque Drivers* for automatic placing and the driving of screws and nuts. Many combinations of standard machines and components are available.



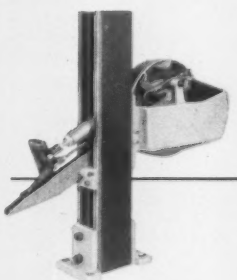
AUTO-POSITIONER

This small-parts assembly machine is available as a completely automatic station (at right) for use at a dial or straight transfer table, or it can be furnished as a self-contained machine with work table and foot treadle to initiate the cycle. Has positive-acting piece-parts feeder and sensing mechanism to stop the machine if part is missing or improperly placed. Easy to install and tool.



AUTO-TORQUE DRIVER

Including all major features of the DIXON Auto-Positioner, this driver for screws and nuts also has a compact air motor and a clutch that provides precise torque control. Furnished as a self-contained machine with foot-treadle control (above) or as an automatic station for use at dial or straight transfer table.



PIECE-PARTS FEEDER

Operated by an air cylinder which actuates the feeder drum and shuttle-type escapement, this feeder delivers parts to assembly machines or other equipment. The straight track and positive-acting escapement permit low-angle mounting and provide efficient parts control.

PARTS ESCAPEMENT

Releases parts singly or in multiples. Simple, efficient, operates at speeds up to 200 per minute. Models for air, solenoid or mechanical operation.

INTERMITTENT DRIVE

A compact clutch-brake unit, designed for accurate start-stop cycling of indexing mechanisms for assembly or other work. Wide range of speeds and torques.

Descriptive Bulletins will be sent on request.

DIXON **DIXON AUTOMATIC TOOL, INC.**
2312 - 23rd Avenue • Rockford, Illinois

EQUIPMENT FOR AUTOMATIC PARTS HANDLING AND ASSEMBLY

Circle 696 on Page 17

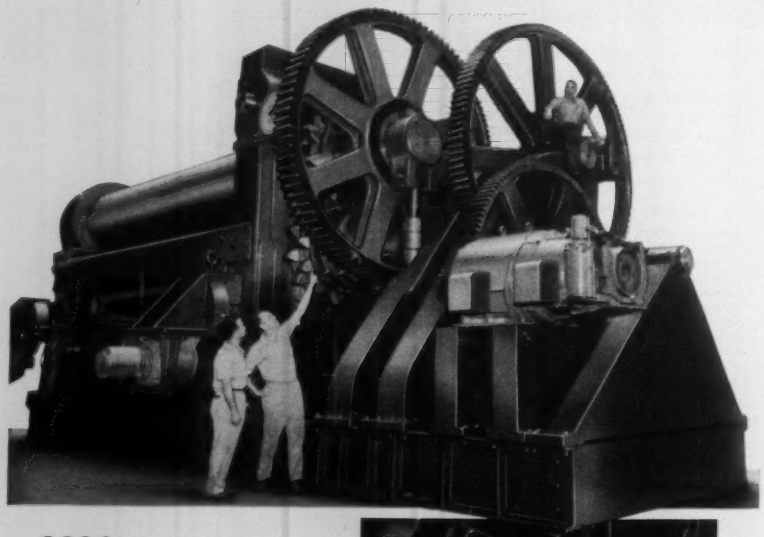
Huge H&S Gears

drive world's largest bending machine

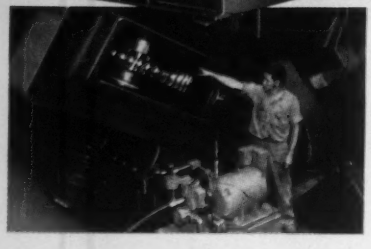
Horsburgh & Scott is proud to have supplied the spur gears that drive this machine—designed and built by Bertsch & Co., Cambridge City, Indiana. Largest of its kind, it bends cold steel plates up to 4¼ inches thick, 16 feet long; weighs over ¾ of a million pounds.

Horsburgh & Scott has facilities to generate gears up to 125″ diameter and to form-mill spur gears up to 160″. We have a complete industrial gear line including worm, helical and herringbone speed reducers.

Tell us your needs. We'll be glad to help you select the proper gearing for you.



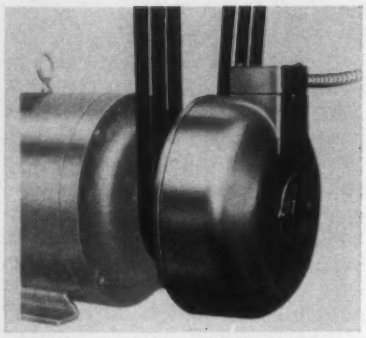
2100-ton pressure shapes hull plates for atomic-powered submarines



H & S bronze worm gears adjust forming rolls

Send for your free copy of H & S Gear Catalog No. 57.

THE HORSBURGH & SCOTT CO.
GEARS AND SPEED REDUCERS
5112 Hamilton Avenue • Cleveland 14, Ohio

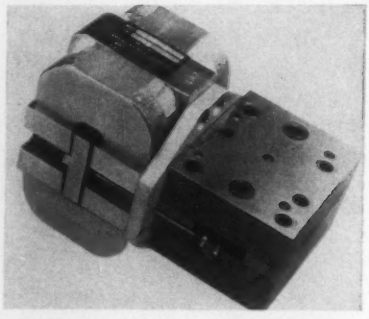


Electromagnetic Clutch

Item 445

Shaft mounted electromagnetic clutch and sheave combination can be installed on an electric motor or any existing shaft extension which has drive requirements from ½ to 50 hp. The drive package includes the protective shroud, sheave, and the clutching unit with complete internal electrical connections. The only external connections are the low-current lead wires to the clutch. A variety of sheave diameters and belt grooves are available to meet different drive requirements. **Cycledynamics Inc.**, 19025 W. Davison Ave., Detroit 23, Mich.

Circle 445 on Page 17



Servo Valve

Item 446

Single-stage, four-way, flow-control valve is designed for use in electrohydraulic servo systems. The valve actuator in Model 200 is a dc torque motor, capable of exerting over 13 lb of force. During normal operation, only part of the capacity of the torque motor is required, but it can exert full force when particle jamming or silting conditions are encountered. This action enables the valve to operate

reliably in contaminated fluids and also provides a zero lap condition. Supply pressure of the valve is 50 to 1000 psi, maximum flow is 0.85 gpm, internal leakage 0.06 gpm maximum, and operating temperature range is from −65 to 265 F. **American Measurement & Control Inc.**, 240 Calvary St., Waltham 54, Mass.

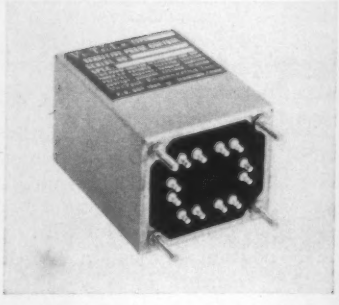
Circle 446 on Page 17

Starter Enclosure

Item 447

Watertight enclosure is designed for company's B and C types of integral horsepower manual starters. By sliding a stainless steel plate over the *Start* button and inserting a padlock, the starter can be locked in the *Off* position. Silicon rubber boots over the pushbuttons prevent the entry of water, dust, or coolant. The *Start* and *Stop-Reset* buttons are made of anodized aluminum and are inserted in the boots. **Square D Co.**, 4041 N. Richards St., Milwaukee 12, Wis.

Circle 447 on Page 17



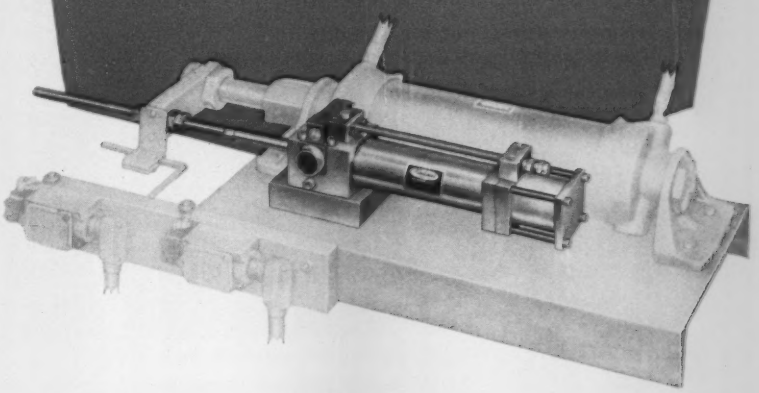
Thyratron Grid Control

Item 448

Self-contained unit is applicable on regulated power supplies, adjust-

Now—Hydraulic Smoothness and Control from your own Air Cylinder plus a

VERI-TROL
TRADE MARK
Hydraulic Checking Cylinder



Designed for use with conventional air cylinders, VERI-TROL hydraulic checking cylinders smooth out stroke variations due to the compressibility of air under irregular load conditions. They're ideally suited for use with air cylinders operating tool or work-piece feeds, precise positioning devices, or wherever you need a smooth, uniform work stroke at any desired pre-set speed. VERI-TROL features (patents applied for) include:

- ACCURATE SPEED CONTROL is dial-set, load-compensated to assure uniform stroke speed even with irregular loads.
- BUILT IN "SKIP," "STOP" OR "SKIP-STOP" controls optional.
- VISIBLE OIL RESERVOIR, easy to refill.
- 2,000 LB. CHECKING CAPACITY on out stroke, free return.
- 2", 4", 6", 9", 12", 15" and 18" checking stroke lengths.

Take the bumps and jumps out of air cylinder operation—install VERI-TROL checking cylinders wherever you want smooth, accurately-controlled stroke speed. Write now for free data bulletin; please address Dept. C4.

Modernair CORPORATION
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36

MEMBER OF NATIONAL FLUID POWER ASSOCIATION

Circle 698 on Page 17

your assembly problem

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- ***Resists oil, heat, impact and abrasion***
- ***Lets products ride or slide, simplifying live backlogging and automatic discharge.***

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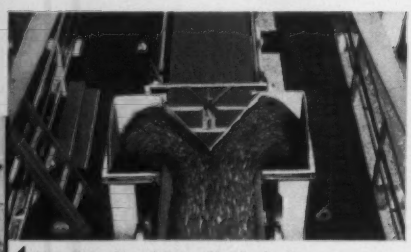
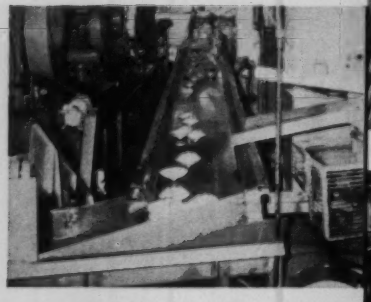
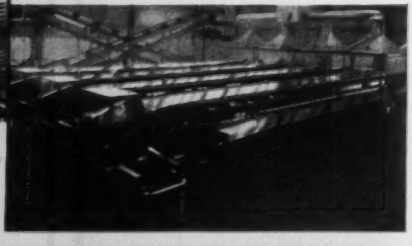
Handling Bulk Materials





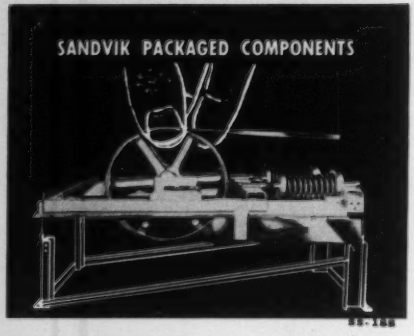
Handling Metal Parts Up An Incline



Sandvik Water-Bed Conveyors Cooling & Solidifying Chemicals

You Can Buy It Complete Or Build It Yourself With

In addition to complete, custom-engineered steel belt conveyors, Sandvik supplies conveyor components in packaged unit assemblies. For example, from Sandvik you can buy the tension end assembly, drive end assembly, steel belt, idlers and discharge devices and Sandvik will provide engineering assistance to help you build or convert to a steel belt conveyor.



SANDVIK STEEL, INC.

SANDVIK STEEL BELT CONVEYORS

Steel Belt Conveyor Department
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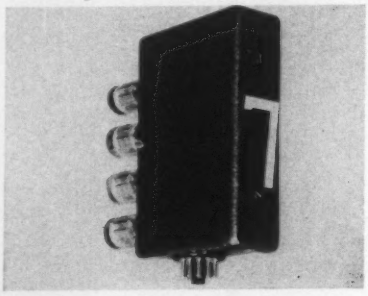
Cleveland • Detroit • Chicago • Los Angeles
IN CANADA:
Sandvik Canadian Ltd., P. O. Drawer 1335, Station O. Montreal 9, P. Q.
Manufacturers of Steel Belt Conveyors for Over 40 Years.

able speed motor drives, programmed speed controls, servomotors, and automatic machine tools for proportional control of thyratron outputs up to 20 kw. The phase-shift of this unit is linear for a full 180 degrees, with a maximum of 270 degrees controlling the output from zero to maximum. When the control signal is removed, the thyratron output is automatically cut off. Four isolated dc control windings are provided to integrate control signals from more than one source. **VecTrol Engineering Inc.**, P.O. Box 1089, Stamford, Conn.

Circle 448 on Page 17



One-Digit Counter

Item 449

Readout has a single-digit display which is 1¼-inch high. A large in-line display can be obtained by mounting several units side-by-side. The digits are formed by from 5 to 11 character segments. All digits lie in the same surface plane so the display can be read throughout a 150 degree viewing angle. Counting rates of 100 kc and 1 mc are available. **Berkeley Div., Beckman Instruments Inc.**, 2200 Wright Ave., Richmond 3, Calif.

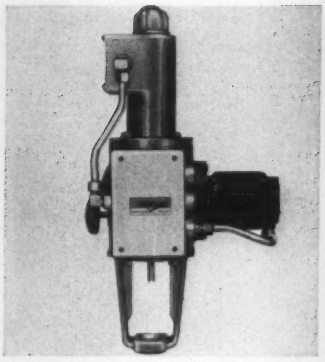
Circle 449 on Page 17

Electric Actuator

Item 450

Device is suitable for throttling control of valves, dampers, louvers, metering pumps, and speed changers. It can also be used for on-off remote pushbutton control with optional position indication. Model D-62XW consists of a gear box, reversible electric motor, slidewire feedback, and limit switches. The proportional positioning is obtained by means of a slidewire feedback used in conjunction with a voltage balance system. Actuator is avail-

Circle 699 on Page 17



able in a variety of travels from ½ to 4 inches, with a maximum thrust of 700 lb. Stroking speeds are from 8.5 ipm at 100 lb load to 2.5 ipm at 700 lb load. An integral positioning stem and mounting yoke make the unit adaptable for field mounting. **Conoflow Corp.**, Dept. D-6, 2100 Arch St., Philadelphia, Pa.

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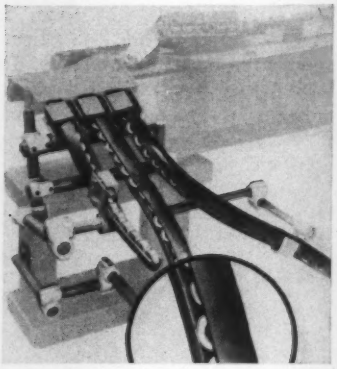

Flexible Feed Track

Item 451

Flexible system permits tracking through crowded machine areas. Unit is constructed with a flexible covering over hardened wire; is impervious to abrasion, acids, oils, and heat to 175 F. The internal carrier wire surface gives hairline contact with parts, permitting an easy flow. The full length slot gives visible part inspection and allows dirt to fall out. The spring wire is flexible, yet it maintains a constant cross section regardless of contortion. Tracking is made in a variety of sizes and shapes—round, square, rectangular, and triangular. **Campbell Machines Co.**, 18634 Fitzpatrick, Detroit 28, Mich.

Circle 451 on Page 17

Circle 700 on Page 17→

your assembly problem

+

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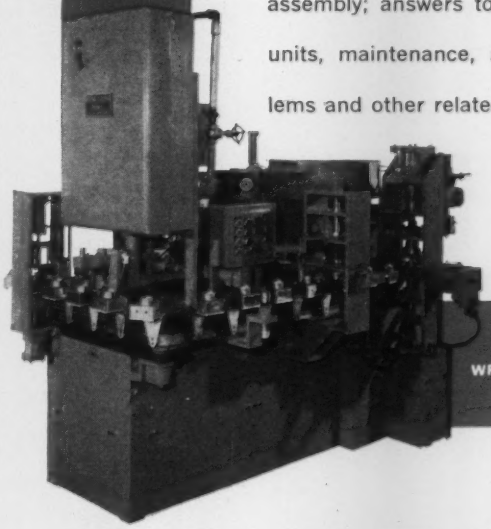
low cost automatic assembly

If your product is one of volume production, it is a prospect for the benefits of automatic assembly: greater production, a reduction in scrap which creates lower unit cost at a higher quality level.

The AUTOMATOR indexing chassis, engineered and built by Benerson, provides the starting point from which Benerson engineers the fixtures and devices for machining, riveting, welding, sorting, orienting, feeding and inspection.

Look into the prospects for automatic assembly of your product. Benerson offers you specific examples of savings introduced in other plants through automatic assembly; answers to your questions on size, range of units, maintenance, mixing operations, redesign problems and other related facts.



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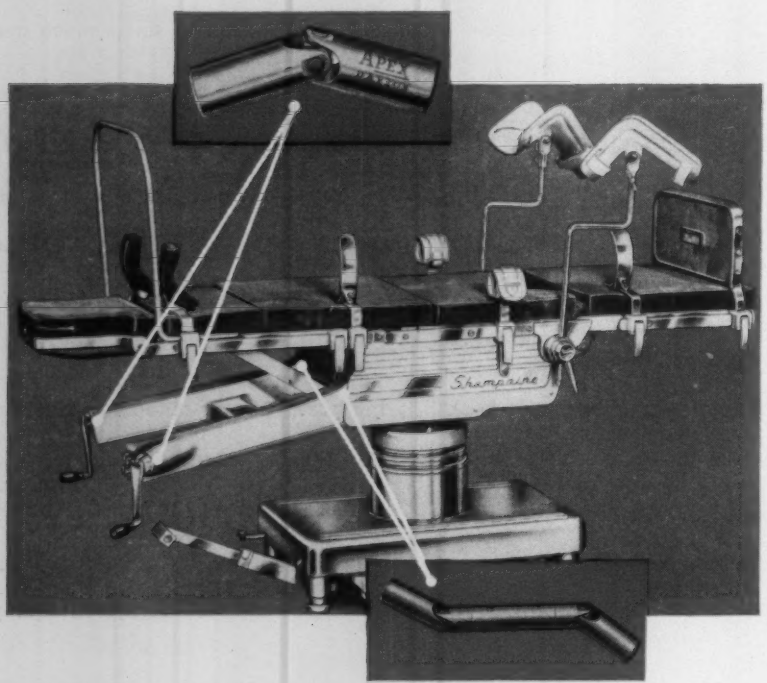
APEX SPECIAL universal joints

The completely new design concept evident in the Shampaine Surg-a-matic major operating table includes four Apex universal joints, each specially designed for a specific application. These joints are components in the push-button controlled mechanism that provides the many intricate and accurate table positionings required by modern surgical techniques.

Two Apex single universal joints are mounted on fixed shafts, serving as universal joints and as extreme angle couplings, and operate freely at a constant 30° angle. Two Apex double universal joints operate at maximum angles of 15° and 27°. All four joints are cadmium plated.



APEX STANDARD universal joints

In addition to "specials," Apex offers a full range of standard universal joints, 3/8" to 4" diameter, including the exclusive Apex covered universal joint for service in fluids, gases, corrosive atmospheres or in extremes of heat or cold. Write, on your company letterhead please, for Catalog 28.

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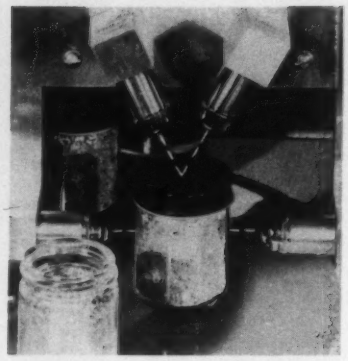
DAYTON 2, OHIO

Phantom view of APEX covered universal joint which operates efficiently in wet or dry, corrosive or abrasive atmospheres, and in extremes of temperatures.



Photoelectric System

Item 452

Miniature device designed for the monitoring of objects moving at varying speeds and positions, features dual light beams—one beam times the inspection and the other beam performs the inspection. The beams can be direct light cut-off, reflected, or a combination of both. In the illustration shown, the control is checking for the presence of bottle caps. The timing beam is cut off by the bottle and the reflecting beam inspects for the cap. In order to pass inspection or assembly, beams must concur. **Photomation Inc.**, 96 S. Washington Ave., Bergenfield, N. J.

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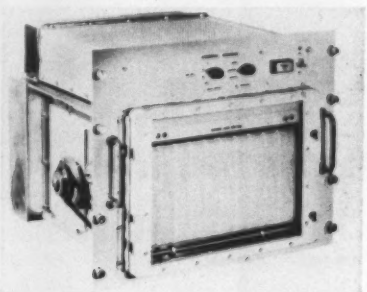

Multichannel Monitor

Item 453

Instrument can record, simultaneously, up to 100 separate and distinct operations and events on a moving chart 12 inches wide. The monitor provides a permanent record of these operations and events, indicating their duration and time relationship to each other. Some of the applications of the unit include: Monitoring control processing equipment, checking automated production lines, and testing tele-

phone switching equipment. Features of the instrument are: A rapid response of up to 500 signal changes per second, a selection of eight chart speeds (by local or remote control), and a paper roll capacity of 500 ft. Power requirements are 105-125 v, 60 cps, 250 w. **Brush Instruments, Div., Clevite Corp.**, 37th & Perkins, Cleveland 14, Ohio.

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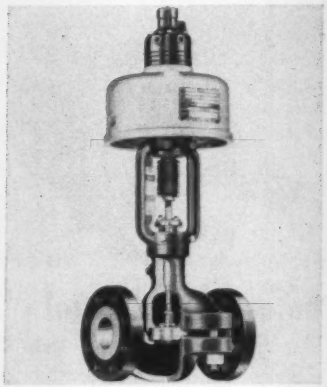
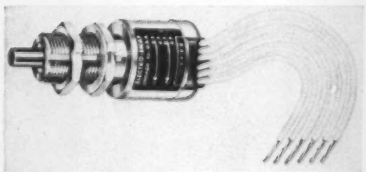


Split-Body Valve

Item 454

Line of split-body control valves is suitable for use in high-temperature, high-pressure control applications. The use of I.S.A. standard face-to-face dimensions makes it possible for units to be interchanged with all standard makes of diaphragm valves. All the components —topworks, valve bodies, line flanges, plug and seat rings are of unitized construction, permitting approximately 430 different valve combinations from a single split-body. **Kieley & Mueller Inc.**, 64 Genung St., Middletown, N. Y.

Circle 454 on Page 17



Limit Switch

Item 455

Unit is applicable on industrial machines for indicating or control operations. All exposed parts are made of stainless steel or monel to

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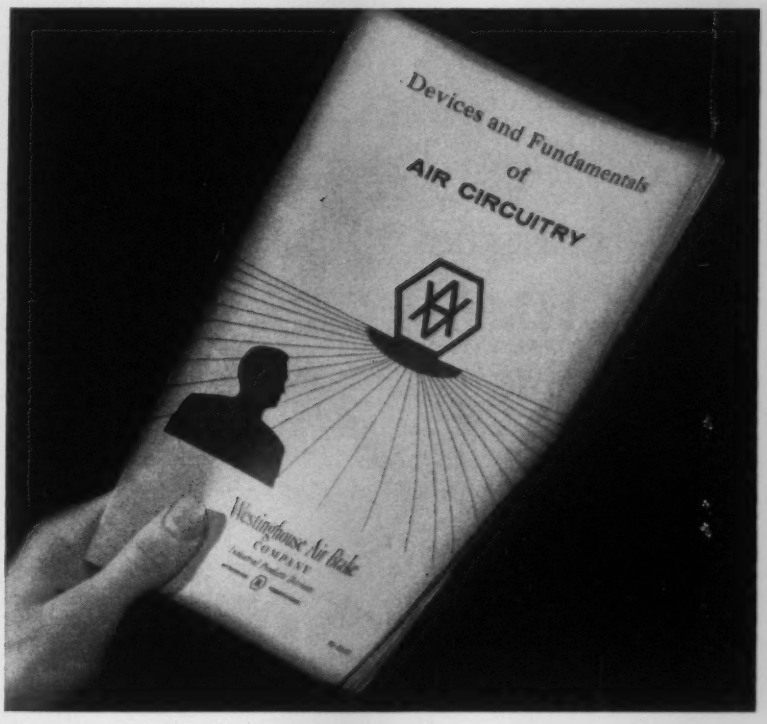

A comprehensive discussion of the 4 basic principles involved in designing an economical "control by air" system for industrial machines and processes.

Westinghouse Air Circuitry means the *control by air* rather than the mere use of it. It deals with the interlocking, sequencing, timing and segregation of events to obtain automatic or semi-automatic control. It is applicable to any automation problem on any industrial machine . . . in any industrial process. The equipment involves uncomplicated mechanical devices with few moving parts. Any mechanic can easily install and service a Westinghouse Air Circuitry system.

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Circle 702 on Page 17

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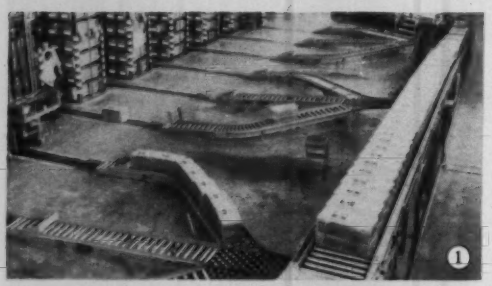

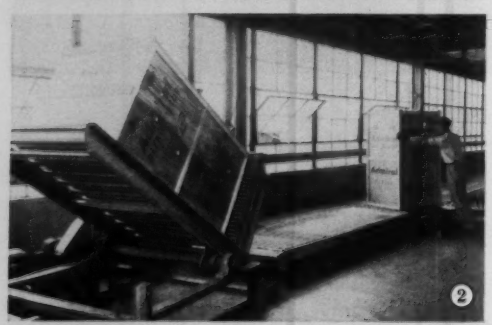

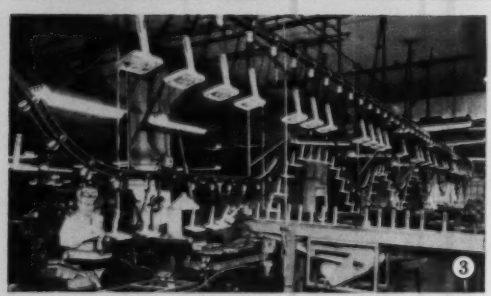

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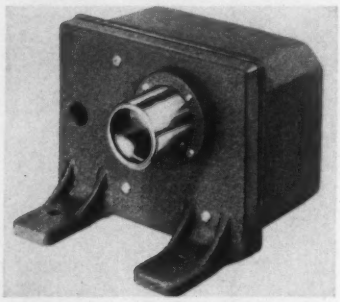
CONVEYORS FOR EVERY INDUSTRY

Circle 703 on Page 17

resist corrosion. Switch can be mounted anywhere through one mounting hole, is infinitely adjustable within 7/8-inch. It allows multicircuit control; has separate terminals which permit numerous circuit combinations. Switch is rated for 28 v dc, 4A Res. **Switch Div., Electrosnap Corp.**, 4230 W. Lake St., Chicago 24, Ill.

Circle 455 on Page 17

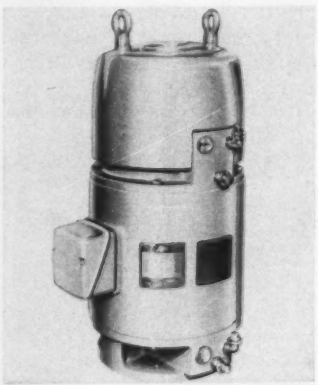


Photoelectric Control

Item 456

Device features a cadmium cell sensing element with magnetic amplifier for high speed photoelectric operation. Model BM1 requires 10 ft-c minimum light with 0.04 second minimum dark time and 0.04 second minimum light time. The control relay energizes when light is on the sensing element. Relay is rated for 10 amps at 115 v ac; power consumption is 5 w. **Autotron Inc.**, P. O. Box 722 RR, Danville, Ill.

Circle 456 on Page 17



Weatherproof Motor

Item 457

Vertical all-weather unit is suitable for shallow or deep-well tur-

bine pump applications in irrigation, petroleum product handling, chemical pumping, or powerplant condenser cooling. The motor, available in ratings of 1 to 30 horsepower, has an oil-metering system, sealed bearing chambers, and magnetic drain plugs to collect ferrous particles in the oil. Because of its efficiency the motor requires a minimum of cooling air. This reduces the amount of dust and moisture drawn into the motor by the air stream. Ninety degree turns in the air flow system prohibit the entrance of snow and rain. Noncorrosive screens keep out foreign matter and rodents. Optional features for the motor include: Nonreverse ratchet, part winding or increment start connections, bearing and winding temperature detectors or thermoguards, space heaters, and snow covers. **Louis Allis Co.**, Dept. P, 427 E. Stewart St., Milwaukee 1, Wis.

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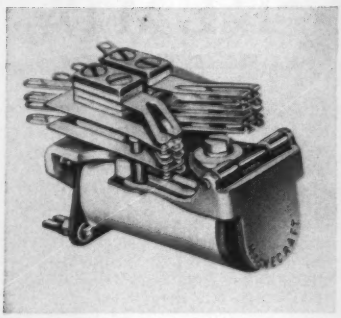
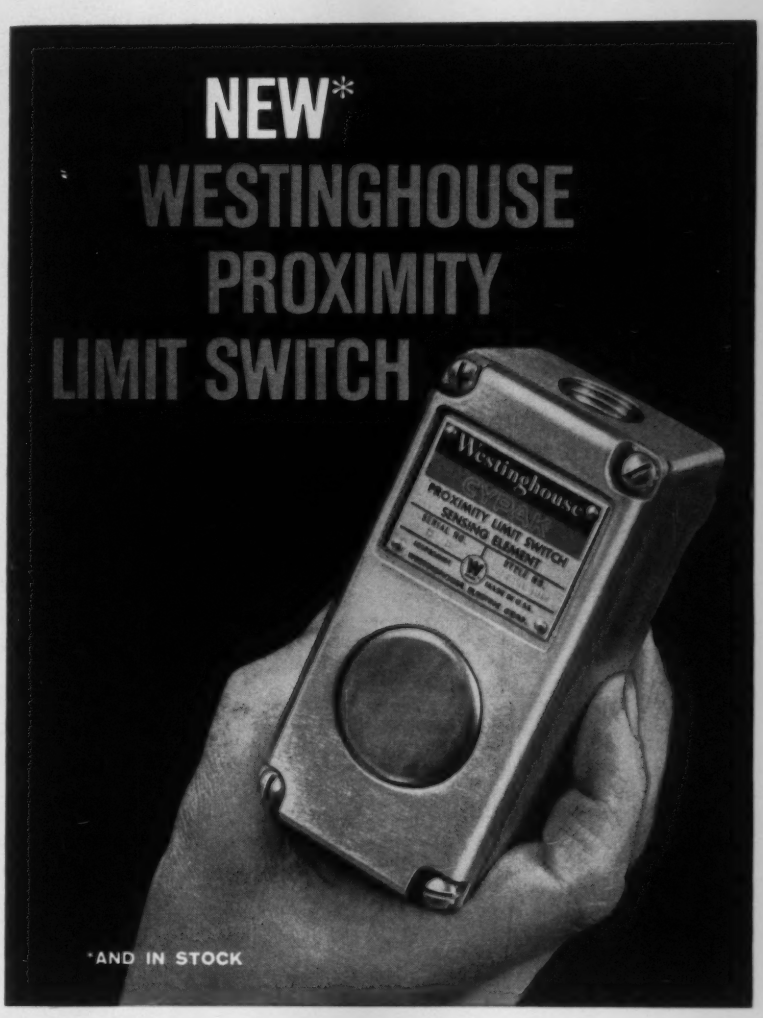


Telephone Type Relay

Item 458

Miniature relay features a heavy duty full yoke type armature hinge with large bearing surfaces which are reamed for precision fit of a centerless ground stainless steel hinge pin. Unit is available with contact combinations to 8PDT for operation from dc voltage to 230; to 4PDT for operation from ac voltage to 440; and to 8PDT with full wave rectification for operation from all frequencies including 25, 50, 60, and 400 cycles. Nominal dc power requirements are 3 w; maximum for continuous duty 5 w; ac nominal volt-ampere requirements are 5 va. There is a wide selection of contacts ranging from bifurcated gold alloy for low level signal circuits to 15 amp heavy duty contacts for power



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No tubes . . . no moving parts to weaken and fail from wear . . . not affected by dust, dirt, oil mist or iron filings . . . will even operate under water . . . sensing heads available for distances of ½ inch and 2 inches . . . also for explosion-proof applications . . . corrosion and vibration resistant . . . won't spark, pit or wear, because there are no contacts.

Sure, they cost a little more initially. But we haven't seen the application yet where the new Westinghouse proximity limit switch can't pay for itself time and again through eliminated replacements and machine down time.

GET ALL THE FACTS about new Westinghouse proximity limit switches . . . see how and where they can benefit you. Write to Westinghouse Electric Corporation, Director Systems Department, 356 Collins Avenue, Pittsburgh 6, Pennsylvania. J-01011

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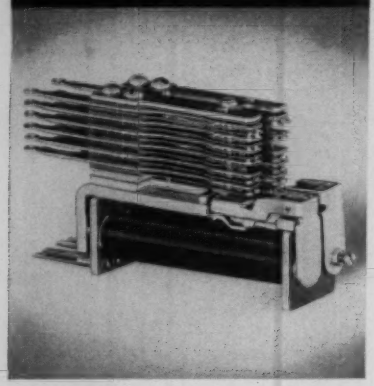
Circle 704 on Page 17

Stromberg-Carlson

"TELEPHONE QUALITY"

Relays



. . . available immediately for any part of your operation that depends on electromechanical switching.

Proven by many years of meeting the exacting requirements of the telephone industry, these twin-contact relays of unsurpassed reliability are available in many types. The following are representative:

Type A: general-purpose relay with up to 20 Form "A" spring combinations. This relay is excellent for switching operations.

Type B: a gang-type relay with up to 60 Form "A" spring combinations.

Type BB relay accommodates up to 100 Form "A" springs.

Type C (illustrated): two relays on the same frame. A "must" where space is at a premium.

Type E: has the characteristics of Type A relay, plus universal mounting arrangement. Interchangeable with many other makes.

Complete details and specifications on all Stromberg-Carlson relays are contained in our *new relay catalog*. Contents include: spring combinations, table of equivalents, contact data, variations and special features, plus complete mounting and cover information.

The catalog is available on request.

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S-C

Circle 705 on Page 17

switching. **Magnecraft Electric Co.**, 3354D W. Grand Ave., Chicago 51, Ill.

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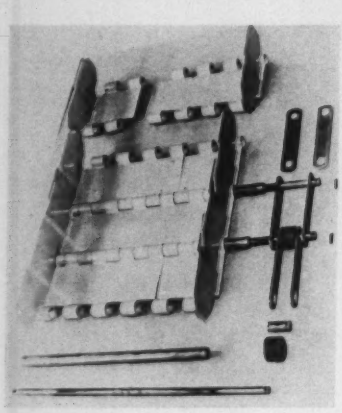
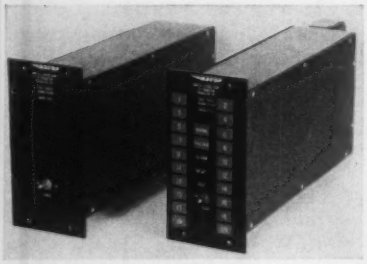


Hinged Pan Conveyor

Item 459

Suitable for handling scrap, conveyor is designed with multiple closely-fitted pan joints that leave no opening during movement in which scrap can become wedged or clogged. A continuous deep, moving pan is formed by side flanges and scrap is prevented from spilling over in transit. Each hinged-pan conveyor is a self-contained unit consisting of a head and tailshaft assembly mounted on steel framework and installed in a trench beneath floor level. The pan is constructed of 12 gage steel. Where a hinged-pan conveyor has an inclined section, 4-inch high steel cleats are fitted to the width of the pan. These cleats restrain scrap from sliding back when being elevated. **Gifford-Wood Co.**, Hudson, N. Y.

Circle 459 on Page 17



Alarm System

Item 460

System can monitor industrial processes at long or short distances.

MINIATURE MANIFOLDS

for

Multi-Purpose CONTROL

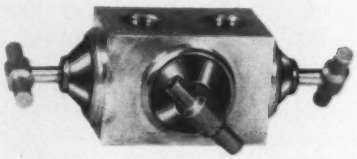


Photo ½ actual size

"DEMI" M2 SERIES

All models of the standard Dahl "Demi" M2 series of three-valve manifolds are readily adaptable to clean liquid, gas and vapor applications. The size of these manifolds makes them especially suitable for pilot plant, aircraft and marine applications, flow control and automation. They are miniature in size, yet their patented form for bubble-tight shutoff makes them comparable to much larger valves in performance.

These manifolds consist of two block valves and one bypass valve in place of 3 separate valves . . . they eliminate two tees, four nipples and eight threaded connections. Models of the "Demi" M2 series come in a variety of barstock materials and may be ordered with special features such as: bolted bonnets, swaged-in TEFLON seats, toggle actuators, etc.

PRESSURE RATING Metal Body & Diaphragm Neoprene Diaphragm	 750 psi at 450°F 100 psi at 180°F
MAXIMUM Cv	0.4
CONNECTIONS	1/16", 1/8", 1/4" N.P.T.

Send for the "DEMI" Catalog D-1 and other technical data on Dahl pneumatic and hydraulic valves.

GEORGE W.
DAHL
COMPANY, INC.

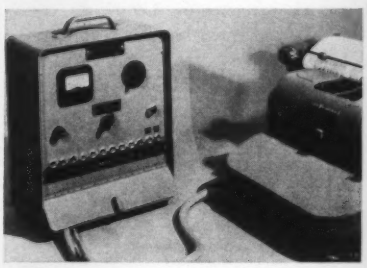
86 TUPELO STREET, BRISTOL, RHODE ISLAND

Circle 706 on Page 17

Operations such as pipeline pumping stations, electric substations, industrial plant operations, and unattended microwave repeater stations can be handled by this system. System consists of a scanner-transmitter unit (left in the illustration) and a receiver-annunciator unit (right). Heart of the system is the transistorized ring counter scanner which monitors up to 20 separate items at a scanning rate of 10 points per second.

Each monitored item is represented by a switch. If the switch is open; normal and safe operating conditions are indicated. If the switch is closed, a pulse is generated by the scanner-transmitter unit and a flashing lamp, plus audible alarm, signals the off-normal condition at the receiving-annunciator unit. Alarms continue until they are cancelled by the operator. The alarm system requires only one communications channel, ranging from a pair of wires to a subcarrier radio or microwave channel. Entire system operates from 115 v, 60 cycle ac or 125 v or 48 v dc. **Applied Science Corp. of Princeton,** P.O. Box 44, Princeton, N. J.

Circle 460 on Page 17



Typewriter Tester

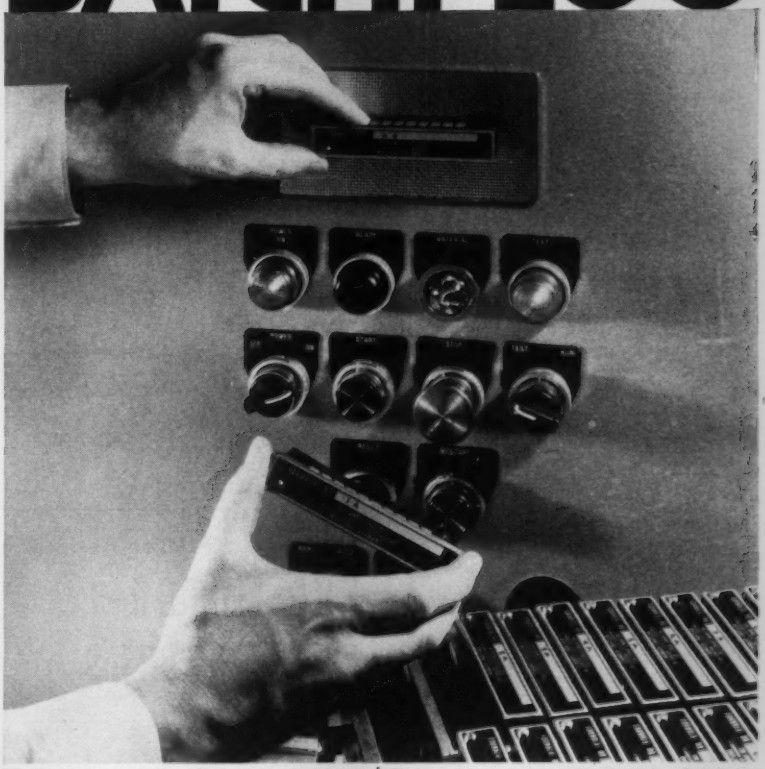
Item 461

Device tests automatic typewriters which are used for data systems. Tester automatically operates each keyboard solenoid electrically in a predetermined sequence, does not require the operation of the entire data system. Malfunctions and momentary hang-ups are isolated and identified by comparing the printed test record with a master record. **Hanson-Gorrill-Brian Inc.,** 85 Hazel St., Glen Cove, L. I., N. Y.

Circle 461 on Page 17

NEW LOW COST AUTOMATIC BATCHING
WITH INSTANT FORMULA CHANGING

HOWE BATCHPLUG

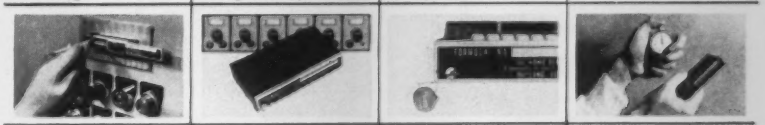


1 Quickly and easily adjusted to accurate settings.

2 Each standard Batchplug controls up to 10 ingredients, 3 scales.

3 Sealed for privacy—no dials to reset—no operator error.

4 Inserting Batchplug changes entire plant to new formula instantly.



The Howe BATCHPLUG cuts panel and circuit costs—puts automatic batching in everybody's reach! Simple, rugged, easily set for any formula up to 10 ingredients. An exclusive Howe development!

HOWE

THE HOWE SCALE CO. • RUTLAND, VT.

A SUBSIDIARY OF SAFETY INDUSTRIES, INC.

WRITE TODAY FOR OFFICE DEMONSTRATION OR NEW BATCHPLUG FOLDER

Circle 707 on Page 17

MARK IT *as you* **MAKE IT!** *for Profit Saving*

By incorporating a Matthews' Marking Station in your processing. Whether your product is round, contoured or flat; metal glass or plastic . . . one of Matthews' Marking applications is ideal for you.

Equipment to print, emboss, indent (by roller or stamping) or blast-etch marking is adaptable to most automatic operations.

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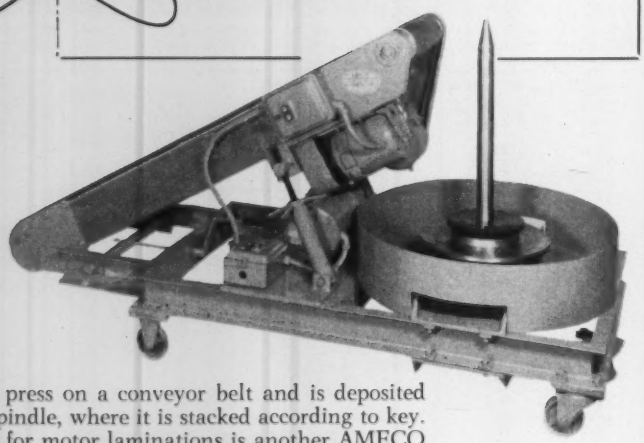
Circle 708 on Page 17

AMECO

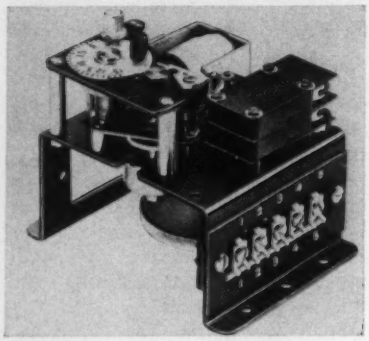
ORIENTER FOR MOTOR LAMINATIONS



Blank leaves press on a conveyor belt and is deposited on rotating spindle, where it is stacked according to key. This orienter for motor laminations is another AMECO product for the motor industry.

Some choice territories still open

AUTOMATION MACHINES & EQUIPMENT CO., INC.
3130 W. MILL ROAD, MILWAUKEE 9, WISCONSIN



Time Delay Relay

Item 462

Unit is designed to provide an adjustable time delay between the operation of a control circuit and the transfer of one or two load switches. It can be used on machine tools, batch processes, heat treating units, and electronic devices. Time ranges are available from 15 seconds to 24 hours, with range adjustment from approximately 10 to 100 per cent of full scale. Repeat accuracy is within 2 per cent, reset time approximately ½ second. Switch ratings are 10 amp, 125 v or 5 amp, 250 v ac, resistive load. Motor and clutch ratings are 115 and 220 v, 25, 50, and 60 cycles. **Cramer Controls Corp.**, Centerbrook, Conn.

Circle 462 on Page 17

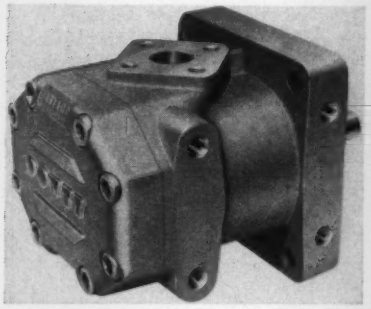
Weight Printer

Item 463

Instrument indicates and permanently records weight, strain, temperature, pressure, and other variables which are measured by sensitive bridge-type transducers. Model 176 gives continuous monitoring and permanent periodic recording

of the variable in printed tape form at rates up to two readings per second. Controls are provided for run and calibration selection. An automatic readout-time-interval selection is optional. **Gilmore Industries Inc.**, 13015 Woodland Ave., Cleveland 20, Ohio.

Circle 463 on Page 17

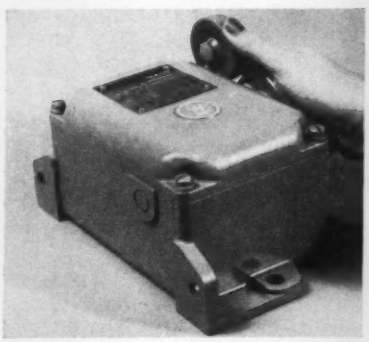


Hydraulic Gear Pump

Item 464

Line of pressure-balanced hydraulic gear pumps, designed to operate at pressures to 2500 psi, is applicable on presses, machine tools, and fork lift trucks. There are 14 sizes in 4 groups with outputs ranging from 1 to 60 gpm. All sizes are available for either clockwise or counterclockwise rotation. The noise level is said to be low with pulsation levels remaining constant in amplitude throughout the operating range. Either flange or foot mountings are furnished. **Berry Hydraulics, Div., Oliver Tyrone Corp.**, Corinth 1, Miss.

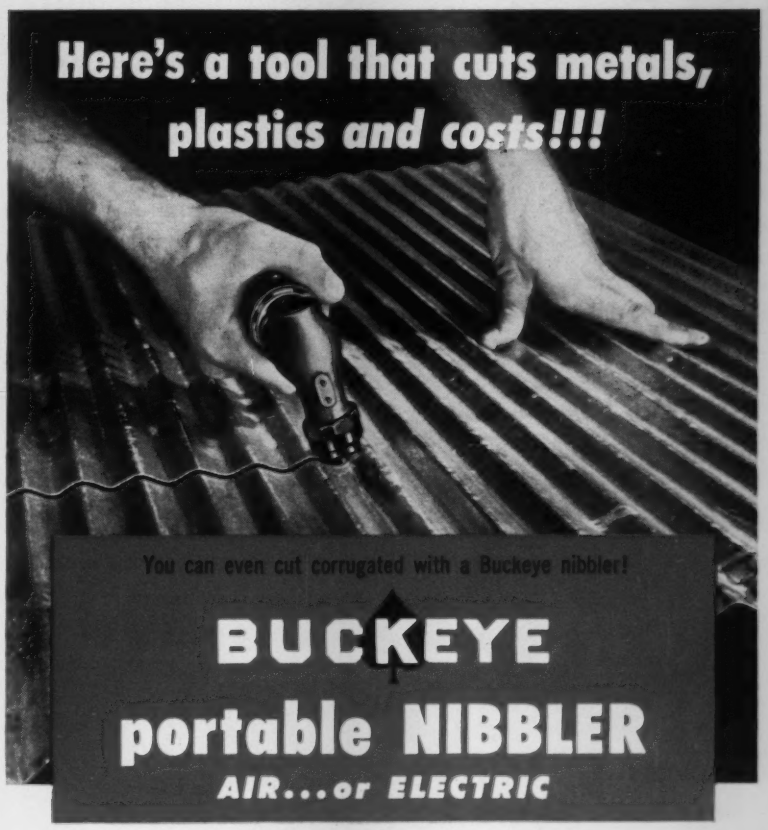
Circle 464 on Page 17



Heavy Duty Limit Switch

Item 465

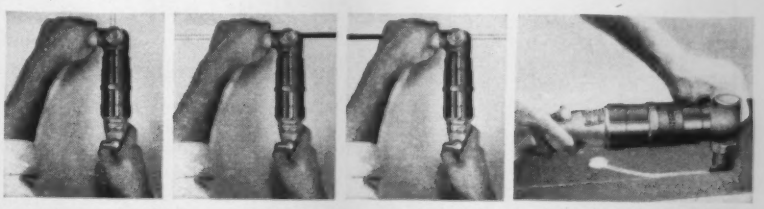
Line of heavy duty limit switches incorporates one or two cam-opened, spring-closed, slow acting


Here's a tool that cuts metals, plastics and costs!!!
You can even cut corrugated with a Buckeye nibbler!
BUCKEYE
portable NIBBLER
AIR...or ELECTRIC

Eats right through 8 gauge mild steel at a 5-6 foot-per-minute rate. Makes a sharp, clean cut, free of distortion on sides, top and bottom. Works on materials of any size or shape. Starts cutting anywhere on the work, follows any contour, in any direction.

Now — bring the tool to the work, eliminate handling time and costs on large, cumbersome workpieces. Now — use this economical, portable tool for cutting metals and plastics, keep expensive, stationary machinery available for regular work.

Pick your type of power — air or electric — from ten models of the Buckeye nibbler, one designed for your kind of work.



CUT STRAIGHT AHEAD . . . TO THE LEFT . . . TO THE RIGHT . . . FOLLOW ANY CONTOUR

WRITE FOR CATALOG

Write, on your company letterhead please, for your free copy of Catalog G-10, listing all Buckeye air tools—drilling, fastening, abrasive and specials.

INDUSTRIAL AIR TOOLS SINCE 1920

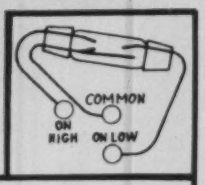
Buckeye Tools CORPORATION

5009 SPRINGBORO PIKE, DAYTON, OHIO

Circle 710 on Page 17

Three Operations One Control

MULTI-PURPOSE PRESSURE CONTROL



Single pole, cut in high (close on rise)

Single pole, cut in low (open on rise)

or Single pole, Double throw

PROVIDES

- External Adjustments
- Repetitive Trip Point
- Repetitive Reset Value
- Visible Calibrated Dial
- Visible Contact

Note Minimum Differentials for each Range

Adjustable Operating Range Psig	Maximum Momentary Surge	Min. Diff. Psig
0-30" Vac.*	30	2"
10" Vac. 12# *	30	1#
0-14#	30	1
0-20#	30	1
0-35	50	1¼
0-60	125	3
0-60	150	6
0-100	125	3¼
0-100	200	6
0-100	300	6
0-150	200	7
0-150	240	8
0-150	300	8
0-200	240	8
0-200	300	8
0-300	400	12
0-300	600	14
0-600	800	50
0-1000	1500	75

Series DA 20, 30, 50, 60, listed by UL and CSA

THREE CASE STYLES AVAILABLE

GENERAL PURPOSE (NEMA 1) Illustrated —for indoor use.

WEATHER-PROOF (NEMA 1A, 2, 3, 4,)— for outdoor use.

EXPLOSION-PROOF (NEMA 7)—for hazardous locations.

WRITE FOR CATALOG NO. 858

THE MERCOID CORPORATION

CHICAGO 41, ILL.

Circle 711 on Page 17

switching elements. The switching elements can be adapted for one or two normally closed circuits, one or two normally open circuits, or one normally open and one normally closed circuit. Operating lever of the switch is self-centering and can be provided with a rubber or a steel wheel. It will operate the switch when moved in either direction; travel limits are 45 degrees in either direction. Initial force required to move the lever is 2 lb; final force to hold the lever is 6 lb. Model HDH is rated up to 600 v at a maximum continuous current of 25 amps ac or dc. Permanent magnet blowouts can be added to double the interrupting capacity. **Westinghouse Electric Corp.**, P. O. Box 2099, Pittsburgh 30, Pa.

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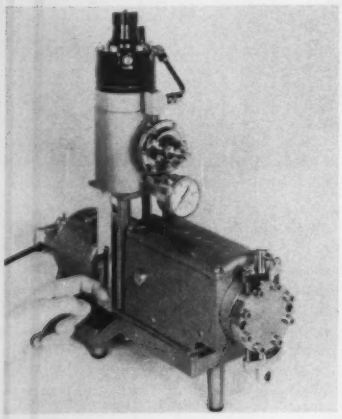


Metering Pump

Item 466

Automatic metering pump can adjust the pumping rate from zero to full capacity by signals from pneumatic instruments. Unit is a combination piston-diaphragm pump. Output of the pump (from zero to 100 per cent) is controlled by air pressure variation from instruments with a range of 3-15 psig. In operation, an air cylinder is integrally mounted above the pump stroke adjustment mechanism. Variations in air pressure are mechanically transmitted through a piston and cam to the stroke adjusting mechanism which controls the pump output.

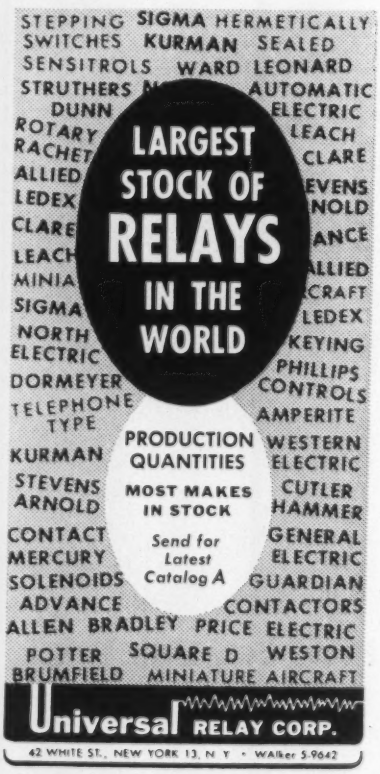
The reciprocating piston within the pump forces oil to move a dia-

a CASE summer short course in NUMERICAL FEEDBACK CONTROL

Case Institute announces a two-week short course in Numerical Feedback Control. This course is directed toward both industrial and military personnel whose technical activity is concerned with guidance, control, or the generation of control function from discrete and/or discontinuous numerical intelligence. The course will be conducted at Case Institute of Technology, Cleveland, Ohio, July 6 to July 17, 1959. Inquiries should be addressed to: Mrs. Jean Yates, Office of Special Programs,

CASE INSTITUTE OF TECHNOLOGY
UNIVERSITY CIRCLE
CLEVELAND 6, OHIO

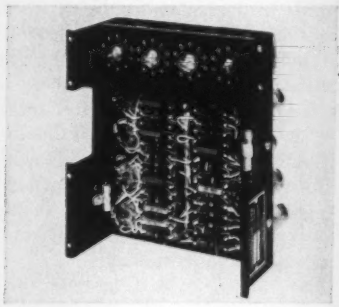
Circle 712 on Page 17



Circle 713 on Page 17

phragm forward and back. The back stroke takes the liquid chemical into the reagent head through section check valves. The liquid is forced through the discharge valves on the forward stroke. The diaphragm and check valves are the only working elements exposed to the chemical being pumped. Theoretical capacity ranges from 1040 to 2300 ml/hr at 0 psig. Pressures to 2000 psig can be handled. **Process Equipment Div., Lapp Insulator Co. Inc.**, 100 Hall St., Leroy, N. Y.

Circle 466 on Page 17



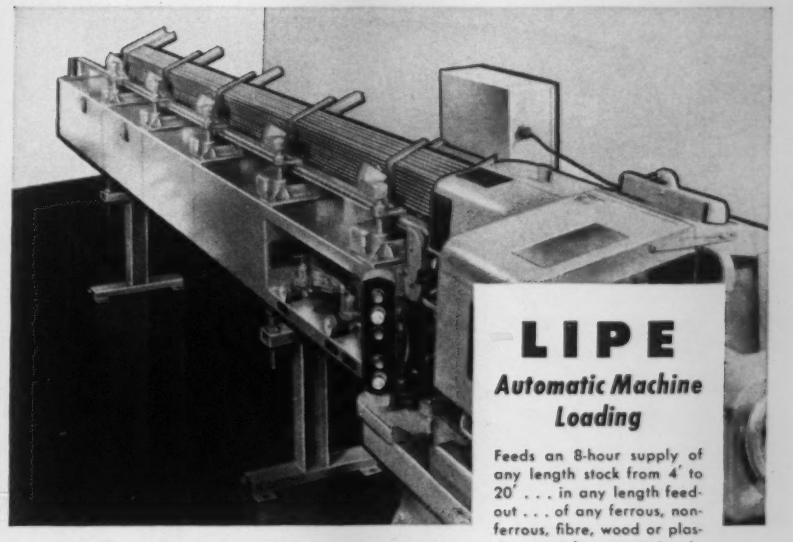
Digital Timer

Item 467

Miniature four-decade digital timer has a time resolution of 1 millisecond and a maximum indicated time interval of 9.999 seconds. Model 2400 uses four glow transfer tubes as decade counters and indicators; has two twin triodes to drive the counting tubes.

In operation, pulses derived from a 1000 cps tuning fork are fed to a gated amplifier, which is controlled by miniature *Start* and *Stop* thyratrons. A pulse defining the beginning of an interval triggers the *Start* thyratron, at which time the gated amplifier passes pulses to the counting unit. A pulse defining the end of the measured interval triggers the *Stop* thyratron, closing the gate. The registered count is the elapsed time in milliseconds. A manual reset switch returns all counters to zero and resets the thyratron gate-control tubes. Timer is rated for 24 to 28 v, but it can be used with a conventional power supply using a 60 cps, 117 v line voltage. **Erie Resistor Corp.**, 644 W. 12th St., Erie, Pa.

Circle 467 on Page 17


LIPE
Automatic Machine Loading
Feeds an 8-hour supply of any length stock from 4' to 20' . . . in any length feed-out . . . of any ferrous, non-ferrous, fibre, wood or plastic material . . . ranging in diameter from 1/16" to 1 1/2".

Continuous Automatic Feed

of bars, rods, tubing in practically every shape used!

LIPE AML Bar Feeds will give you faster, finer production with less scrap and refinishing and a more efficient use of manpower.

They are applicable to a wide variety of machines, including single-spindle automatic screw machines, turret lathes, centerless grinders, abrasive-wheel cut-offs, punch presses, cold headers, die machines and others.

Sold and serviced by franchised distributors in principal industrial areas. Write or wire for complete information.

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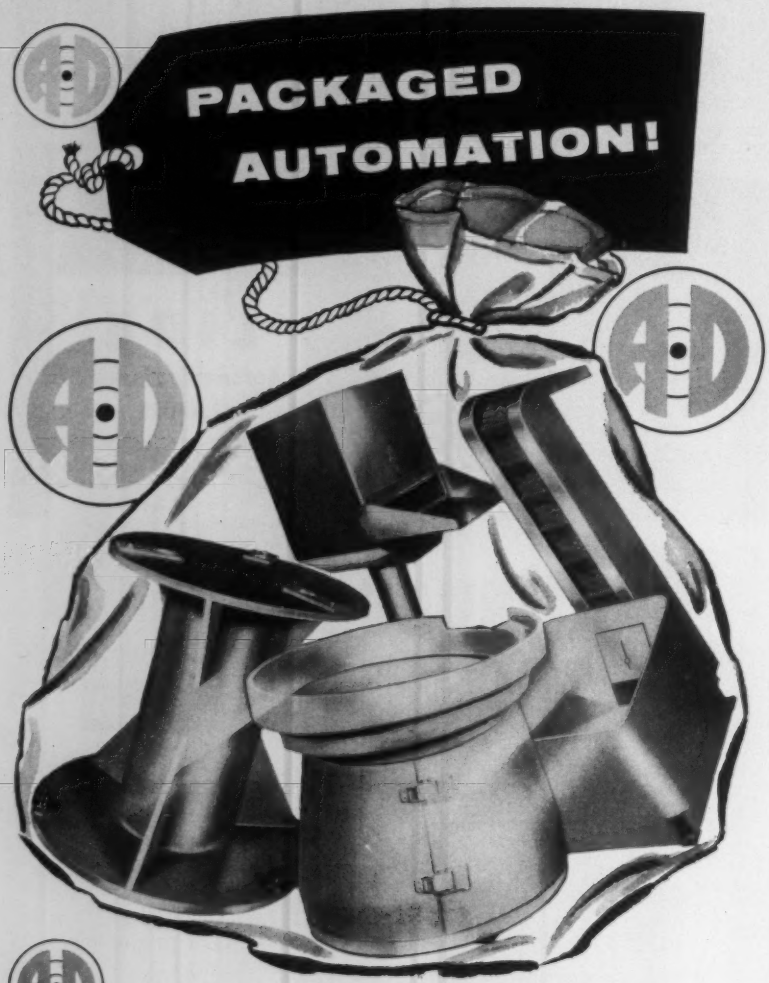
LIPE ROLLWAY — Lipe-ROLLWAY CORPORATION SYRACUSE 1, N. Y.

PIONEERS IN PNEUMATIC BAR-FEEDING

Circle 714 on Page 17

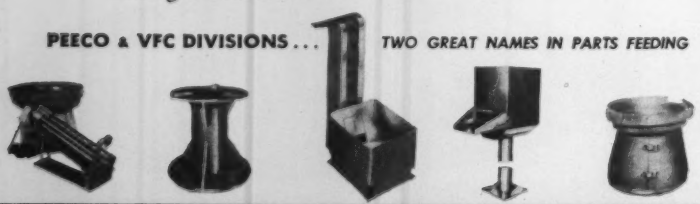


Achieve efficient, automatic production, and produce more all along the line, by integrating equipment designed and built by AUTOMATION for automation.

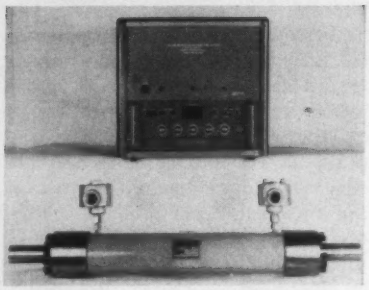
For example, vibratory parts feeders perform more efficiently on an engineered base permitting maximum power transmission. Either the side delivery or the elevating conveyor supply hoppers (with automatic paddle type relay switch to regulate delivery) hold large quantities of parts and are real labor savers. These are just a few advantages that make automation work and pay for itself.

You can depend on the proven talents at AUTOMATION DEVICES, INC.—enlist their help. Write today for the informative bulletin on "Packaged Automation."

PEECO & VFC DIVISIONS . . . *TWO GREAT NAMES IN PARTS FEEDING*



AUTOMATION DEVICES INC.
ERIE, PENNSYLVANIA



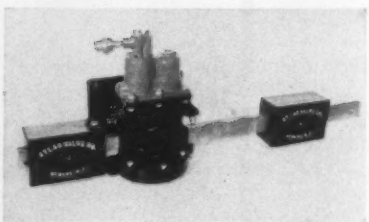
Gas Flow Totalizer

Item 468

Designed for high pressure gases, system can measure flow directly in pounds and display in digital form either the totalized mass flow or the mass flow rate, or both. The system includes a transducer, a servo amplifier, and a digital totalizer or digital flow rate indicator. It can operate interchangeably with various gases such at nitrogen, oxygen, air, helium, and others. It can also be used with gaseous mixtures of unknown constituency.

The range covered is 0.07 to 7 lb per second at pressures up to 6000 psig over a temperature range of −100 to +250 F. Over-all accuracy for either totalization or flow rate indication is ±2 per cent of total reading. The totalizer presents totals from 0.1 to 9,999 lb by means of glow tubes and totals from 1 to 999,999 lb on a mechanical register. The digital flow rate indicator indicates mass flow rates from 0.07 to 7 lb per second with glow tubes. System will operate from a 115 v, 60 cycle power source. **Inertial Instruments Inc.**, 1738 Colorado Ave., Santa Monica, Calif.

Circle 468 on Page 17



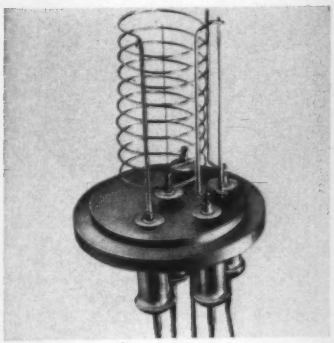
Pressure Regulator Pilot

Item 469

Applicable for control on heating and service mains, vats, and press-platens; pressure regulator pilot can reduce and regulate the

pressure of steam, air, gases, and liquids within fractions of one pound in one stage. It can also be used to maintain a constant level in open tanks or as a pump governor where a constant delivery pressure is required. Model 8000 uses air or water pressure to actuate the control valve. It can be used with single and double seat valves ranging from ½ to 12 inches. The lever or beam is mounted on knife-edge bearings. The control responds to changes of only a few ounces per sq in. Use of outside water or air pressure provides the regulator with ample power to close the main control valve tightly. **Atlas Valve Co.**, 280 South St., Newark 5, N. J.

Circle 469 on Page 17



Ionization Gage

Item 470

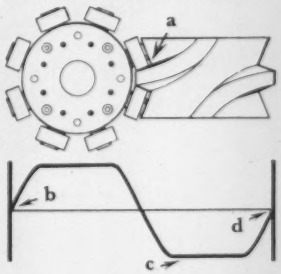
For use in all-metal and bakeout vacuum systems, ionization gage can be used as a measuring instrument both in the high vacuum region (1 mu and less) and the ultra-high vacuum region (below 10^{-8} mm Hg). Non-burnout thoria-coated iridium is used as the filament in the gage. The helical molybdenum grid is outgassed by passing a current of approximately 10 amp through it. A double tungsten filament gage is available for applications where accidental exposure to air is unlikely, or where special atmospheres limit the use of thoria-iridium. The ionization gage control circuit designed for use with this gage enables readings from 1 mu to 2 times 10^{-10} mm Hg. Other circuits can also be used. **Veeco Vacuum Corp.**, 86-P Denton Ave., New Hyde Park, L. I., N. Y.

Circle 470 on Page 17

Critical Points in Acceleration Characteristics of Indexing Devices

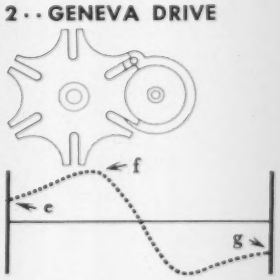
Maximum speeds of production machines are frequently affected by performance limitations of their indexing mechanisms. The efficiency of the indexing mechanism, itself, is dependent upon the amount of shock, vibration and other dynamic forces involved in the starting, stopping and rate of change from maximum acceleration to maximum deceleration.

FIG. 1 · · FERGUSON DRIVE



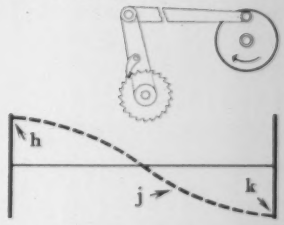
The acceleration curves of such mechanisms provide a graphic means of evaluating and comparing dynamic conditions that affect the performance of the indexing device and the machine. The Ferguson Drive in Fig. 1 is a cam indexing mechanism employing preloaded bearing followers rolling along a tapered cam rib. Two followers are in contact with the rib at all times (a) maintaining a zero backlash condition and an accuracy of .001″ without auxiliary locating devices. This Drive features a modified trapezoid acceleration characteristic . . . a combined cycloidal and gravity curve. The Ferguson Drive has an initial force of zero (b) and a smooth, sinusoidal increase. Its maximum acceleration value (c) is very low and the change through maximum deceleration to zero (d) is gradual. These smooth indexing characteristics of the Ferguson Drive permit operation of production machinery at speeds as high as 2,000 RPM, if necessary, with a minimum of 8,000 hours operation while maintaining extreme precision and zero backlash.

FIG. 2 · · GENEVA DRIVE



The six-stop geneva drive shown in Fig. 2 is representative of the geneva family in that its dynamic forces are instantaneously applied and the initial acceleration force is fairly high (e) with an even higher maximum acceleration (f). The change to maximum deceleration is gradual but there is an almost instantaneous stop (g). When operated at high speeds, geneva drives wear out quickly and cause heavy vibrations that seriously affect the life of the machine and product quality.

FIG. 3 · · RATCHET & CRANK



The rachet and crank has a distorted cosine acceleration curve (a true cosine curve is illustrated in Fig. 3) with an extremely high initial acceleration (h). The descent to maximum deceleration (j) is gradual but, as with the geneva drive, stopping is instantaneous (k). Even with auxiliary braking action, overtravel is extreme and accuracy is very poor. Rachet and crank devices have very limited use in modern production machines.

FIG. 4 · ·

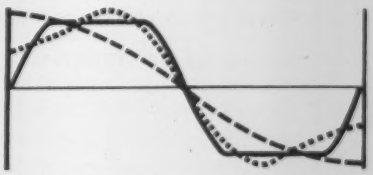


Fig. 4 shows the curves of the three mechanisms on the same diagram. Note that only the Ferguson Drive has an initial force of zero and the lowest maximum acceleration value combined with a gradual change to maximum deceleration. *This is why the Ferguson Drive does what no other indexing device can do!*

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Circle 716 on Page 17

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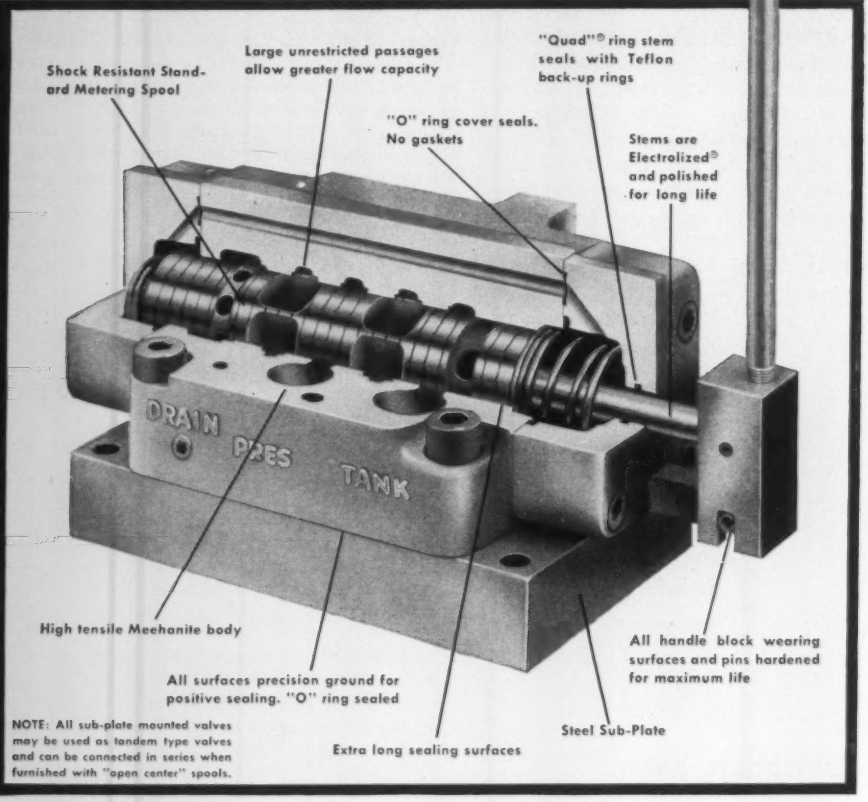
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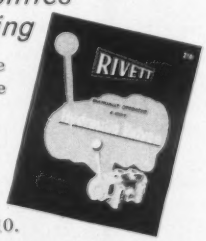
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catalogs and literature

Latest automation information. For copies use card on page 17.

Basic Automation Units

Industrial & Automation Div., Radio Corp. of America, 12605 Arnold Ave., Detroit 39, Mich.—9 *data sheets*—"Building-block" type automation machines for mechanizing and integrating production and assembly operations are described. The types of machines covered include floor feeders and orientors, rotary hoppers, self-compensating grinder controls, high speed automatic hardness testers, and electronic inspection systems for multiple dimension gaging and selective segregation of parts. Principles of operation, applications, and features of the various units are given.

Circle 471 on Page 17

Tape Controlled Machine

Burg Tool Mfg. Co. Inc., 15001 S. Figueroa St., Gardena, Calif.—8 *page bulletin*—Tape controlled 6 and 8 spindle turret drilling, tapping, and boring machines are described. Machines include an automatic numerically controlled positioning table with a GE modified tape control unit. Bulletin explains how to program a part, how to prepare the tape, and how to operate the machine.

Circle 472 on Page 17

Handling Equipment

Prab Conveyors Inc., 30121 Groesbeck Hwy., Roseville, Mich.—47 *page catalog*—Catalog 600 contains data on Magnavator, an automatic elevator for handling small parts magnetically; and Tube-Veyor, an enclosed bulk material handling conveyor with a two-directional chain. Schematic drawings show various applications and arrangements. Also described is custom built equipment such as feeder conveyors, bucket elevators, screw conveyors, vibrators and vibrating conveyors, and flux and chip handling systems.

Circle 473 on Page 17

Finishing Equipment

Industrial Equipment Div., R. C. Mahon Co., East 8-Mile Rd., Detroit 34, Mich.—12 *page booklet*—Data are given on finishing systems for porcelain enamel, synthetic enamel, lacquer, paint, varnish, and japan finishing. Included in the booklet is a discussion of equipment such as drying ovens, soldering ovens, processing ovens, steel hoppers, and steel conveyor racks. Special units for curing rubber, glass bonding, coating welding rods, and preassembly cylinder-head heating is also covered.

Circle 474 on Page 17

Chopper Application

Seminole Div., Airpax Products Co., Fort Lauderdale, Fla.—23 *page handbook*—Factual information on chopper techniques are given in booklet entitled, "The Contact Modulator." The chopper is the connecting link between low or zero frequency, low level, transducer, and the amplifying system. It is designed to increase transducer output to a usable value. Points discussed include the use of choppers in electronic functions and the selection of the proper type. Also included is a glossary of chopper and amplifier terms.

Circle 475 on Page 17

Metal Turnings Crusher

American Pulverizer Co., 1249 Macklind Ave., St. Louis 10, Mo.—8 *page bulletin*—Crushers which reduce metal turnings to shoveling chips are described in Bulletin 159. Data are given on six models ranging in capacity from 2½ to 50 tph. Illustrations show installations of conveying systems, turnings crushers, and chip wringers.

Circle 476 on Page 17

Digital Logic Systems

Semiconductor Div., Hoffman Electronics Corp., 930 Pitner Ave., Evanston, Ill.—8 *page bulletin*—Twelve applications for logic modules are described in booklet entitled, "Simplified Design of Digital Logic Using Magnalog System." The system consists of three basic 7-pin plug-in modules and a series type pulse magnetic amplifier. Each application has a recommended power supply circuitry and is illustrated by a logic diagram, wiring diagram, and waveshape photo.

Circle 477 on Page 17

Cold-Saw Machines

Consolidated Machine Tool Div., Farrel-Birmingham Co. Inc., 565 Blossom Rd., Rochester 10, N. Y.—12 *page booklet*—Two types of cold-saw machines with hydraulic feed are described in Bulletin 537-A. The machines are designed for cutting ferrous and nonferrous metals, in saw-blade diameters ranging from 32 to 120 inches. Data are given on the cutting speed, spindle horsepower, type of spindle drive, and design of work-clamping device.

Circle 478 on Page 17

Servo Component Definitions

Norden Div., United Aircraft Corp., Ketay Dept., Commack, L. I., N. Y.—12 *page booklet*—Definitions for rotating servo components are given in Bulletin 560. It covers Mil spec type synchros, resolvers, servo motors, and tachometer generators. Symbols which identify the units are explained as are characteristics of units.

Circle 479 on Page 17

Motor Starter Centers

Richardson Scale Co., Clifton, N. J.—4 *page pamphlet*—Mounting motor starter centers in control panels are discussed in Bulletin 58-C. Advantages in savings, maintenance, and operations are explained. Illustrative examples of the centers mounted in control panels are included.

Circle 480 on Page 17

Work-Holding Components

Jergens Tool Specialty Co., 712 E. 163rd St., Cleveland 10, Ohio—84 *page catalog*—Data are contained in Catalog 201 on line of work-holding equipment, chuck jaw blanks, handles, knobs, wheels, strap clamp assemblies, and forged items. Engineering drawings are included for each item listed. The catalog contains a unique illustrated index as well as a master photograph of items available keyed to section of catalog where detail information can be obtained.

Circle 481 on Page 17

Worm Gear Speed Reducers

Winsmith Inc., 27 Eaton St., Springville, N. Y.—12 *page booklet*—Data are given in Catalog HSDR-58 on two types (torque arm and flange mounted) of double reduction hollow shaft worm gear speed reducers. Each type is available in three sizes covering an output range from 0.041 to 2.552 hp, a ratio range from 66-2/3:1 to 4466:1, and a maximum output torque range of 1380 to 7678 lb-in. Unit dimensions, dimensions for high speed and

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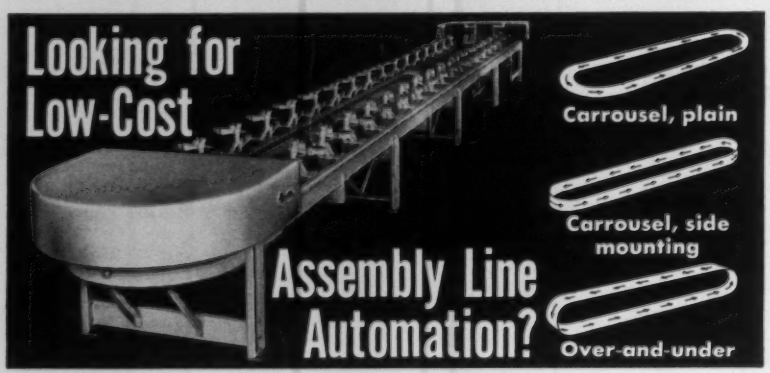
Circle 718 on Page 17



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Circle 719 on Page 17

slow speed shaft bores, plans and elevations of all shaft arrangements, and tables of weights for both type of reducers are given.

Circle 482 on Page 17

Aluminum for Heat Exchangers

Reynolds Metals Co., Dept. PRD-2, Box 2346, Richmond, Va.—16 page booklet—Aluminum usage in heat-exchanger fabrication is discussed in Bulletin 732-1-1. Aluminum heat transfer rates, temperature properties, tensile strengths, pressures and dimensional tolerances are described. Charts give data on aluminum stress values, working pressures, thermal expansion and conductivity, and friction factors.

Circle 483 on Page 17

Bulk Handling

Dracco Div., Fuller Co., 4063 E. 116th St., Cleveland 5, Ohio—12 page booklet—Pneumatic conveying methods for automatic bulk handling are discussed in Bulletin 531. Details are given on two polyethylene handling installations to show how air conveying can solve various problems. Photos and diagrams show the step-by-step process through production, between plants, and in-plant distribution at the processor.

Circle 484 on Page 17

Electrolytic Conductivity Units

Industrial Instruments Inc., 89 Commerce Rd., Cedar Grove, N. J.—32 page catalog—Equipment for the measurement of electrolytic conductivity is covered in Catalog 23. Data are given on equipment such as Solu bridges, conductivity bridges, conductivity indicator controllers and recorders, selector switches and alarms, temperature compensators, and steam and condensate analyzers. Construction of the conductivity cell is explained, the different type cells are described, and a chart lists the types of cell holders available.

Circle 485 on Page 17

Instrumentation Literature

Industrial Div., Minneapolis-Honeywell Regulator Co., Wayne & Windrim Aves., Philadelphia 44, Pa.—24 page catalog—Available literature from the Industrial and Valve Div. is indexed in Bulletin G2-1a. Included in the list are product catalogs, specification sheets, technical bulletins, systems bulletins, and instrumentation data sheets. Educational aids and company services are also mentioned.

Circle 486 on Page 17

Variable-Speed Drives

Reeves Pulley Co., Div., Reliance Electric & Engineering Co., Columbus, Ind.—8 page bulletin—Data are contained in Bulletin G-5812 on line of variable-speed drives which provides infinitely adjustable output speeds from a constant rpm motor source operating from standard in-plant ac circuits. Mechanical construction features, condensed drive specifications, and available speed variations are given. Accessories for the units are also covered.

Circle 487 on Page 17

Potentiometer Definitions

Clarostat Mfg. Co. Inc., Dover, N. H.—7 page pamphlet—Potentiometer definitions are given which are applicable to both wire-wound and composition controls. Performance charts are included to help explain some of the terms.

Circle 488 on Page 17

Overhead Conveyor Systems

Chainveyor Corp., 5618 E. Washington Blvd., Los Angeles 22, Calif.—12 page booklet—Overhead conveyor systems which are applicable in plastics and packaging operations, cleaning and automotive industries, and other industries are described. Data are given on components in the system such as straight line drives, takeup assemblies, power curves, and automatic lubricator. Schematic drawings show typical arrangements and position of the various components in the system.

Circle 489 on Page 17

Compressed Air Dryer

Van Products Co., 5806 Swanville Rd., Erie, Pa.—12 page booklet—A large volume compressed air dryer is described which is designed to extract both water and micronic particles and dry the air to low dewpoint quality in volumes sufficient to protect various plant operations. Principle of operation is explained and data are given on the construction and sizes of the automatic drain valve. A schematic diagram shows a typical installation and various graphs list dewpoint, and operating capacities (up to 3000 cfm).

Circle 490 on Page 17

Data Accumulator

Computer Dept., General Electric Co., Deer Valley Park, Phoenix, Ariz.—8 page bulletin—Model GE 302, a data accumulator for the automatic inspection of tinplate, is described in Bulletin GEA-6537A. Features such as the magnetic drum, transistors, and dual channel checking are explained. Schematic drawings display the operation of the unit and illustrations show maintenance features.

Circle 491 on Page 17

Extension Type Flowmeter

Fischer & Porter Co., 823 Jacksonville Rd., Hatboro, Pa.—6 page pamphlet—A glass tube variable-area flowmeter that gives positive indication of flow rate and provides positive means of synchronizing secondaries, is described in Bulletin 10A1700 O/U. The meter is designed for direct connection to transmitting, recording, or controlling instruments. Charts list flow capacities and schematic drawings show dimensions of various styles.

Circle 492 on Page 17

Motor Application

Century Electric Co., 18th & Pine Sts., St. Louis 3, Mo.—16 page booklet—Factors to consider when selecting a motor are discussed in Bulletin 270A. Polyphase, single phase, and direct current motor selection charts describe typical motor driven equipment, show starting and running torques for such equipment, load characteristics, starting currents, speeds, and

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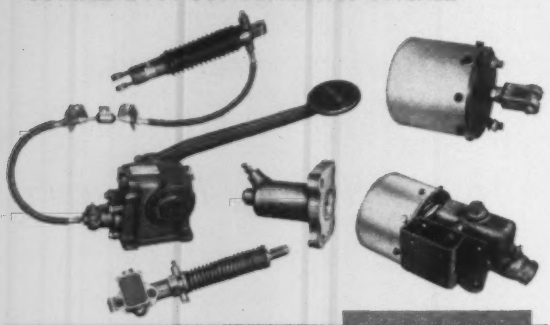

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Circle 720 on Page 17

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Circle 721 on Page 17

available enclosures. Also included are notes on the gearmotor line and selective speed drives.

Circle 493 on Page 17

Pinch Valves

Mine & Smelter Supply Co., 3800 Race St., Denver, Colo.—10 page bulletin—Line of pinch valves applicable in ore milling plants, cement plants, and sand and gravel operations is described. Sketches show the valve construction, and operation of components such as the closing mechanism and torque arm reducer is explained. Also included are tables listing service recommendations.

Circle 494 on Page 17

Overhead Conveyor

Conveyor Div., Columbus McKinnon Chain Corp., Tonawanda, N. Y.—6 page pamphlet—Power and free overhead conveyor system, which features a route selector dispatch head, is the subject of Bulletin 159. The route selector dial can be set to automatically guide a carrier to any one of 80 stations in the system. The system, its components, and the dispatch head are described and illustrated.

Circle 495 on Page 17

Fluid Proportioning

B-I-F Industries Inc., 345 Harris Ave., Providence 1, R. I.—4 page pamphlet—Instrument, designated Adjust-O-Feeder, is described in Bulletin 1140.20A-1. It is designed for chemical and industrial fluid proportioning over a wide range of capacities and pressures. Cutaway photos show the fluid end construction and capacity charts list pressure ratings, specifications, and dimensions.

Circle 496 on Page 17

Preset Units

Servocontrol, Div., Oilgear Co., 1560 W. Pierce St., Milwaukee 4, Wis.—4 page pamphlet—Construction and specifications of preset units (Model SC-CP12-001) are given in Bulletin 36300. The unit is composed of three assemblies and provides an accurate means of storing variable preset command signals. Sketches show dimensions; installation and maintenance methods are explained.

Circle 497 on Page 17

Pallet Loader/Unloader

Barry-Wehmiller Machinery Co., 4660 W. Florissant Ave., St. Louis 15, Mo.—4 page pamphlet—Automatic pallet loader-unloader, which can stack up to 7 cases high, is the subject of Bulletin 323. Sketches show the step-by-step palleting operation and a diagram displays a typical floor plan arrangement.

Circle 498 on Page 17

AC Magnetic Starters

Cutler-Hammer Inc., 378 N. 12th St., Milwaukee 1, Wis.—15 page booklet—Line of ac magnetic starters in sizes from 0 through 4 for both reversing and non-reversing single phase and squirrel-cage

motors is outlined in Bulletin EN-150. Data are given on component units and elements such as magnet coils, overload relays, contact assemblies, and enclosure types.

Circle 499 on Page 17

Servo Valves

Moog Valve Co. Inc., Proner Airport, East Aurora, N. Y.—6 page pamphlet—Data are given in Catalog 150 on line of pressure control servo valves which can be used directly as force transducers or pressure regulators. Performance charts show various characteristics of the valves and schematic diagrams show installation methods. A list of servo valve terminology is also given.

Circle 500 on Page 17

Tape Control System

Industrial Controls Section, Bendix Aviation Corp., 21820 Wyoming, Detroit 37, Mich.—12 page booklet—Tape control systems for automating machine tool cutting functions are discussed. Step by step, the booklet describes the programming operation, progressing from the tool engineering department through the factory area, until the tape is applied to control a machine tool. Charts also list various case histories.

Circle 501 on Page 17

pH Measurement

Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio—3 bulletins—A pH recorder which consists of an electrode assembly, amplifier, and a potentiometer recorder is described in Bulletins E12-4, E67-5, and E67-6. Operating characteristics and physical characteristics are noted. Cutaway photos show the features of the recorder. Sketches illustrate external mounting dimensions and typical installations.

Circle 502 on Page 17

Centralized Control System

Union Switch & Signal, Div., Westinghouse Air Brake Co., Swissvale, Pa.—4 page pamphlet—Control concept for pipeline systems is discussed in Bulletin 1018. Methods for determining and providing the type of automatic centralized control systems required to meet present and future needs of the oil and gas industries are described, aided by illustrations and drawings.

Circle 503 on Page 17

Pressure Transducers

BJ Electronics, Borg-Warner Corp., 3300 Newport Blvd., Santa Ana, Calif.—3 bulletins—Three styles of high performance pressure transducers are described. Model DP-7 is designed for the measurement of differential pressure in terms of an electrical output. Model GP-15D and model DP-15D are designed for the conversion of pneumatic or hydraulic pressures into a proportional electric signal for measurement under both static and dynamic conditions.

Circle 504 on Page 17

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Circle 722 on Page 17

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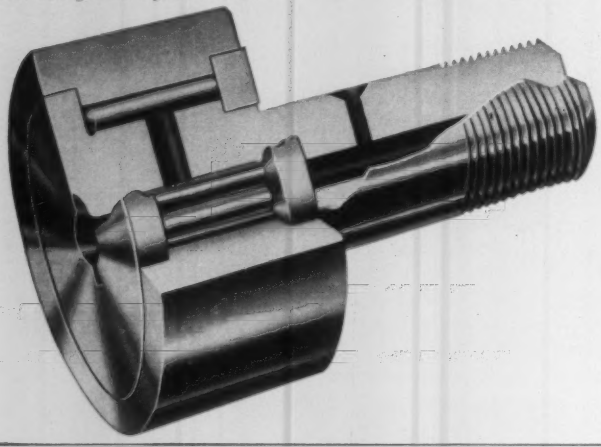
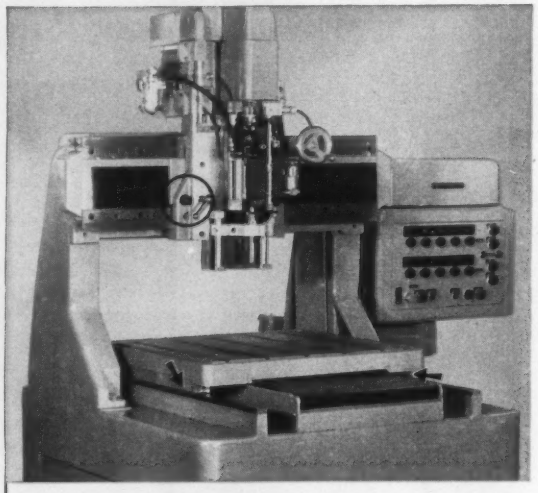
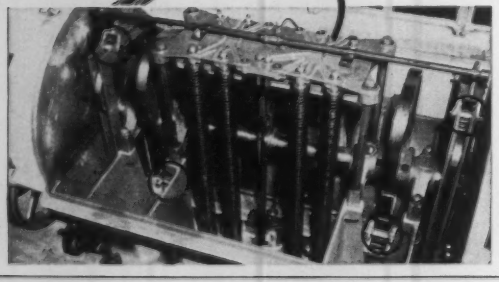




Sealed CAMROL Bearings as table and crosshead rollers in tape-controlled Hillyer drilling machine

CAMROL bearings provide smooth, accurate motion as load carrying rollers for table and crosshead motion of this tape-controlled, precision drilling machine manufactured by Hillyer Corporation. Use of the sealed CAMROL bearings has greatly simplified construction and improved accuracy. They have eliminated the manufacture of shaft and retainer assemblies and increased load capacities. The corrosion resistant finish of the SCF series bearings has also eliminated the need for plating the bearings. Ball bearings formerly used in this application cracked under the same loads. High accuracy of shaft and bearing concentricity eliminates the need for separate adjustments. Operating speeds are 400 RPM and loads are 2000 pounds. The bearings are prelubricated and sealed to keep maintenance at a minimum.

CAMROL bearings take cam action shock in FMC juice extractors



The Food Machinery and Chemical Corporation In-Line Juice Extractor uses McGill CYR-3 bearings as cam followers on the vertically reciprocating beam that carries cups for squeezing juices from citric fruits. A large cam having an 11" total throw drives against the bearings, moving the beam downward. The CYR 1½ cam followers are used to pull another beam upward. The upstroke is a power stroke with 6" total throws.

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AUTOMATION abstracts

FEEDING SMALL PARTS FOR AUTOMATIC ASSEMBLY

By ALLSTON L. HOUSE
Western Electric Co. Inc.
Allentown, Pa.

WHEN engineers at the Allentown Works of Western Electric Co. Inc. were faced with the development of a machine for assembling dry reed switches, they realized that production of a low-cost switch would require automatic loading of the switch parts. They solved the automatic loading problem with three feed systems that employ mechanical and photoelectric devices. The feed systems operate with the high degree of reliability that is essential for efficient machine operation.

The Feeding Problem

There are three parts to a dry reed switch, *Fig.* 1—a glass tube and two identical metal parts called reeds. On the assembly machine there is a separate feed system for each, capable of supplying a part every ten seconds.

Since the glass tube is a symmetrically shaped part, the system for its feeding presented no unusual problems. However, the metal reeds are unsymmetrical. Thus, each reed must be properly oriented before it can enter the assembly machine. Further, some of the reeds are bent, and means were required to prevent jams from this cause.

Reed Feeding Systems

The two reed feeding systems are almost identical, because the parts they handle are identical. They differ only in that they provide opposite directions of orientation of the reeds. The system for feeding one of the reeds of *Fig.* 1 will be described.

The over-all feed system for this reed, *Fig.* 2, includes a vibratory bowl, an orientation device, a bent reed detector, a photoelectric reed-orientation checking device, electrical interlocks, and a transfer arm mechanism.

The vibratory bowl is a commercial unit which accepts parts in bulk and drives them by vibratory action up an inclined spiral track to the start of a feed system. Since by the laws of chance it could be expected that half the reeds arriving at the end of the spiral would be incorrectly oriented, it was desirable to divert the rejects back into the bowl. The orientation device, *Fig.* 3, located in the bowl near the end of its spiral track, performs this function. Since the weight per unit length of the reed is fairly uniform, the shape had to be used as the basis for orientation.

Properly oriented reeds, leaving the orientation device, drop into a bent reed detector. This unit is composed of a hinged section of feed track shaped so that it acts as a gage and a funneling device for guiding acceptable reeds into a feed track. A phototransistor circuit is used for detecting bent reeds that wedge in the track. This circuit controls an air cylinder that opens the hinged track and ejects stuck reeds. Originally, the device was manually operated. It was made automatic when it was found that about 5 per cent of the assembly machine production time was lost because the operator was unable to clear jams immediately.

Located next in the feed track is a photoelectric reed-orientation checking device. Inspecting a reed for orientation while it is falling down the feed track presents a rather difficult problem. It would have been easy to stop the reed, examine it for orientation with a phototransistor system, and use a mechanical gate to accept or reject it. However, the latter approach was not used for several reasons: Stopping the reed would slow the rate of feed; a gate in this type of track would be complicated and slow in operating; and addition of more parts would complicate the system.

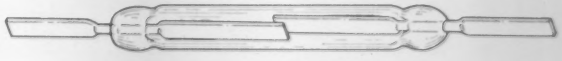

Fig. 1—Sketch of assembled dry reed switch illustrates components used. Two metal reeds and a glass tube are fed to automatic assembly machine for each switch formed. Production rate of machine is 360 assemblies per hour.

The detection device operates on the principle that the round, central section of the reed will pass more light than the flat sections. Mounted in the track are three phototransistors and associated light sources. Their locations are such that a correctly oriented reed will momentarily (for 0.001 second) cover all three phototransistors with its flat sections as it passes down the track. This condition cannot occur if the reed is incorrectly oriented. The very slight difference in phototransistor output between the two conditions is amplified so that it can be used to control a device which accepts or rejects the parts.

The device for accepting or rejecting parts permits

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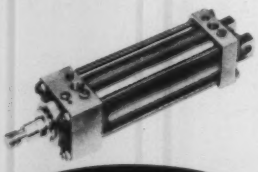

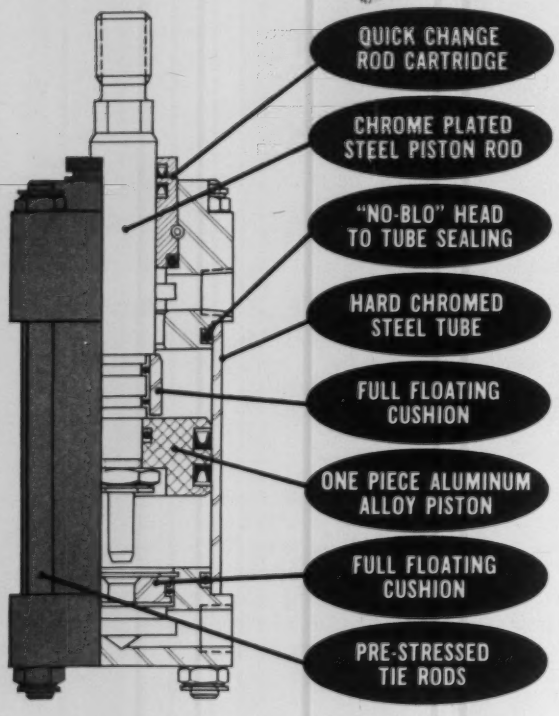
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acceptable reeds to continue down the track, but allows the rejects to fall through a hole in the bottom of the track. This is essentially a trap door arrangement but, in place of a hinged mechanical section, a short blast of air which is controlled by the detection device is applied to support the properly oriented reeds across the hole. A purely mechanical device would be too slow to work in the short time for a reed to pass the hole.

A bottom section of the track acts as a storage magazine from which the transfer arm can obtain parts. The removal of parts is at a constant rate of 360 parts per hour. A phototransistor is mounted in the track so that its light is blocked by the sixth reed in storage. However, when the quantity drops to five or less, light hits the phototransistor which then actuates a control circuit to activate the vibratory bowl. This action continues until there are six units in storage again. The feed rate of the bowl must be high enough to feed reeds to storage faster than the machine removes them, while also supplying those that can be expected to be rejected by the mechanical sorter and other traps in the feed system.

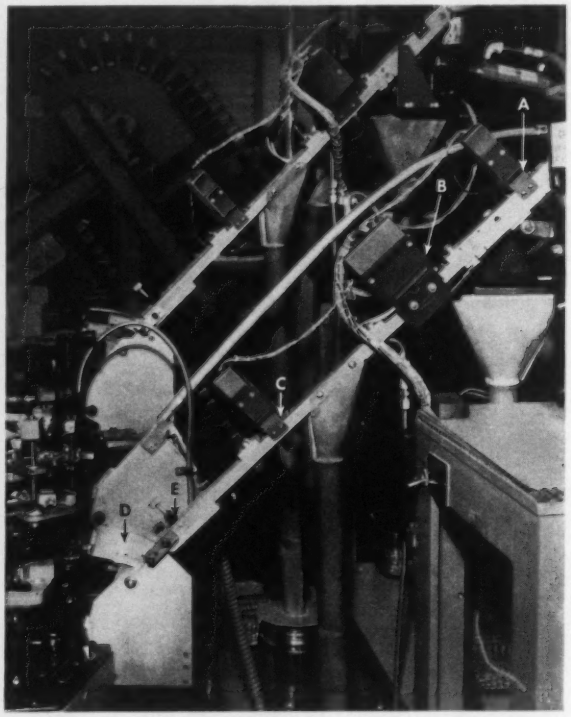


Fig. 2—Feed system for reeds includes: Bent reed detector and ejector, A; photoelectric reed orientation checking device, B; parts supply control, C; transfer arm mechanism, D; and removable track section for jammed reeds, E.

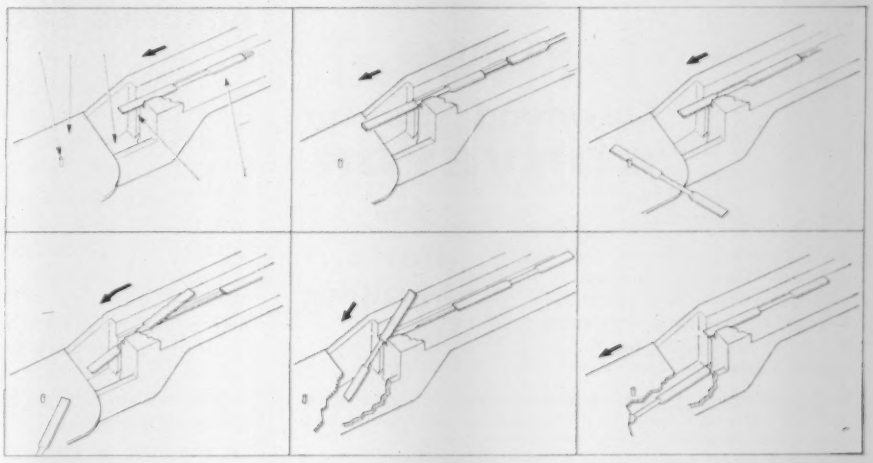
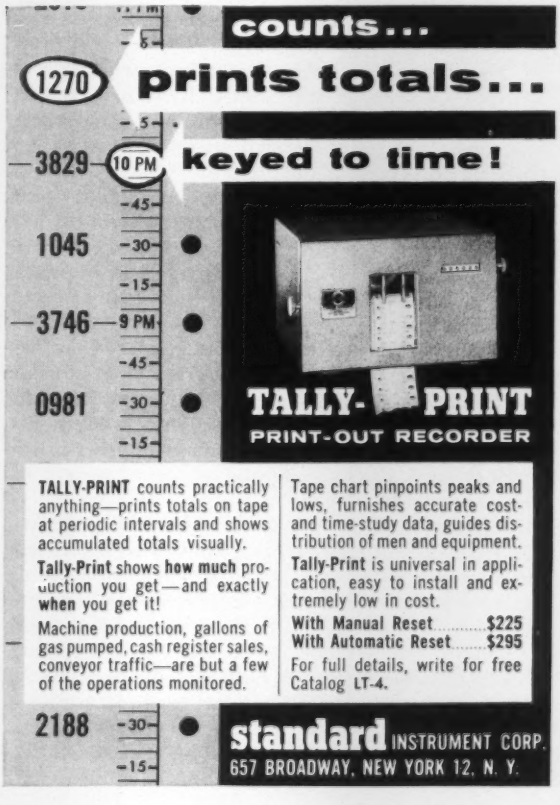


Fig 3.—Sketches illustrate operation of device for rejecting improperly oriented reeds back to vibratory bowl and passing correctly oriented reeds on to feed system. Reeds entering device with their long flat sections forward (top row) can span opening and pass onto inclined surface. A pin on the inclined surface turns the parts as they fall back into the vibratory bowl. Correctly oriented reeds with their short flat sections leading (bottom row) do not span opening, but instead tilt downward to enter track of feed system.

A transfer arm mechanism is used to take the reed from its sloping position in the storage section and revolve it upright for supplying the assembly heads. On the pickup side of the transfer arm are two springs used for holding the reed while it is being transferred. The top of the arm is used to keep the reed in the reservoir from falling out until the arm is in position again. In case there is a jam at this point, one short section of track is made removable. When a jam occurs, the piece can be removed and the troublesome reed easily ejected.

In the early stages of production of dry reed switches, jams occurring in the feed tracks caused more machine downtime than all other causes combined. However, after several months of troubleshooting, with minor changes and adjustments being made, the downtime resulting from the feed tracks is less than one hour per machine per month.

From an article entitled "Automatic Parts Feeding For The Dry Reed Switch Assembly Machines" which appeared in the Western Electric Engineer, Vol. 2, No. 4, Oct. 1958.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NEW Cleveland Vibrator CONVEYOR for Parts Handling

The Cleveland Vibrator Company, Cleveland, Ohio, has announced a new type of vibrating conveyor for handling machined parts, that is powered by an air operated vibrating drive.

The imperceptable vibration of the conveyor moves parts along the tube and speed of movement can be regulated by changing air pressure to the drive mechanism.

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Cleveland Conveyors will feed at an up-hill angle, as great as 20° depending on conditions. This makes it possible to feed parts from floor level into a portable bin, or to other conveyors.

Cleveland Conveyors have only one moving part. There are no bearings, pillow blocks or special stanchions needed. They can be mounted either by pedestal support or overhead suspension.

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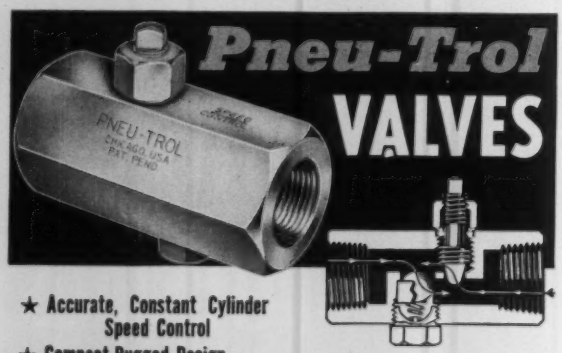

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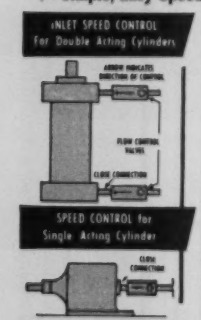

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IMPROVING SMALL-LOT OPERATIONS

By A. F. SCHROEDER
Mfg. Co-ordinator
Transmission & Axle Div.
Rockwell-Standard Corp.
Coraopolis, Pa.

MOST management people in smaller plants think of automation as applying only to large plants with straight-line production and very little setup and changeover. However, automation of handling functions—through use of conveyors, mechanical loading and unloading devices, and transfer devices that automatically move work from one machine to another—can be applied in most plants regardless of size.

It is not uncommon to see operators picking material off the floor or out of a material box and replacing it on the floor or into another box after they have performed an operation. In many such cases a chain conveyor could be employed to advantage. If small parts are being machined, baskets on the chain can be used—baskets or racks painted in various colors can hold different parts.

Roller conveyors can be used for larger parts by placing the parts on pallets or flats, and having the conveyor located so that the operator can pass the material along to the next operation without the necessity of a truck and truck operator. Bypass stations can be installed if it is necessary to stockpile material or parts at a particular operation.

A broad review of current manufacturing methods will often suggest other ways in which material handling time and effort can be reduced, operators more efficiently utilized, and the factory layout rearranged to provide smoother flow of materials with less floor space:

1. Fixtures can be redesigned to accommodate more than one operation at a machine. By moving the fixture and part to the next machine, additional operations might also be performed with one loading and unloading sequence.

2. Machines can often be rearranged so that operations can be combined or several machines tended by a single operator.

3. Manual operations such as burring and inspection can often be performed within the cycle time of a production machine.

4. Chain conveyors equipped with special hooks, baskets, or pigeonhole racks can be arranged to circulate between several machines and washing and inspection stations, thus eliminating the use of stock boxes. Another conveyor could start at an inspection bench and transport parts through packing to the stockroom, or to an assembly line.

5. Transfer-type machines can often be fabricated from standard machines (which may be equipped with special heads) by providing transport rails to move the fixtures between operations. Semiautomatic or automatic operation can be effected by powering the rails and adding limit switches to control machine actions.

6. Mechanical transfer devices can also be added to carry parts between machines. For example, parts can be transported automatically from a centering and cut-off lathe to a turning lathe. Loading of parts into the turning lathe could also be performed automatically.

In this arrangement, one operator might be able to supervise both operations in the over-all time allowed for turning.

7. Use of tape-controlled positioning tables can eliminate the need for special jigs and fixtures and speed up many machine operations. In small-lot drilling, for example, a tape-controlled worktable can save the cost of expensive drill jigs and greatly reduce lead and setup times.

8. Induction hardening of small parts or sections of larger parts is an efficient, rapid process. In some cases the induction heating equipment can be incorporated as a part of a multioperation machine.

9. Issuance of instruction sheets to each operator, listing the operations he is to perform and the tools to be used, is recommended for all plants, both large and small. Such information avoids error, saves setup time, and can result in reduced tool inventories by eliminating the improvisation of special tooling that an operator might otherwise prepare.

From a paper entitled "Remain Competitive" presented at the Annual Meeting of the Society of Automotive Engineers, Detroit, Jan. 1959.

COMPUTERS AND OFFICE AUTOMATION

By HAROLD H. SCAFF
Vice President
Ebasco Services Inc.
New York, N. Y.

A MILD CLIMATE of disillusionment seems to exist regarding computers and office automation. This is probably a healthy reaction from the preceding atmosphere of almost unrestrained enthusiasm. No one now expects the advent of the fully automated, push-button office in anything like the immediate future. However, each month sees the application of additional medium and large scale computers to business data processing, and the extension and refinement of the devices and techniques of office automation. In proper applications, these new tools have demonstrated their potential in two aspects of business cost control.

One aspect of this potential is the prospect of holding down the cost of the data processing activity itself. In view of the present trend of such costs, this possibility is significant. I do not mean to imply that these devices and techniques will result in a major reversal of the upward trend of administrative-clerical costs. I do believe, however, that properly applied, they promise some containment—a slowing down of the relative rate of increase in the cost of paperwork.

Probably of even greater significance is the contribution which these new devices and techniques can make in the methodology of existing control mechanisms. What do these developments promise in this regard? More rapid communication and processing of data will greatly enhance the timeliness and thus the value of control reports. The high processing speed of the newer machinery will permit the processing of data in volumes not heretofore practicable, thus permitting an extension of the range and depth of control reports. Greater flexibility will permit the performance of more complex

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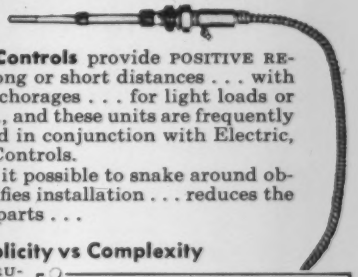

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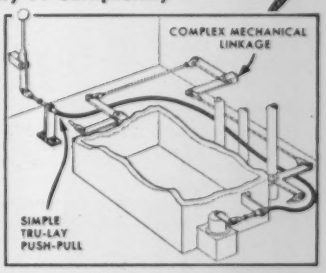

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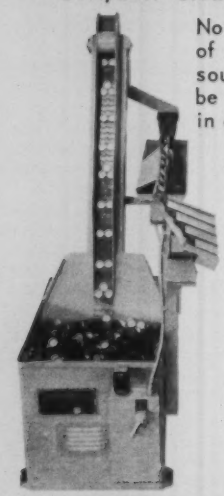

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From a talk entitled "Significant Developments in Cost Control" presented at the General Accounting Conference of the Southeastern Electric Exchange, New Orleans, Oct. 1958.

STANDARDS IN INDUSTRY

By VINCENT dePAUL GOUBEAU
Vice President, Materials
Radio Corp. of America
Camden, N. J.

THE KEY WORD to effective standardization is "continuing." We have learned that you cannot take an occasional look at standardization and expect to achieve anything solid and enduring. Standardization is a full-time basic industrial function whose activities affect the performance of every other operating function of the business.

In the American Standards Association, the Electronic Industries Association, RCA, and in other associations and companies, standards are limited to a maximum 5-year life. Many standards fall before the tide of progress in less than that time. Those that survive the 5-year period are subject to critical review before they are continued as is or in revised form.

These are vitally important policy decisions. They require continuous effort by standards experts on the industry level and, above all, on the company level where it is often necessary to act long before a standard can be cancelled or modified on a national scale.

Standardization benefits are available in every industry area in which purchasing and manpower dollars are committed. These areas include components; products; and facilities such as production and processing machinery, maintenance stores, and office supplies, equipment, and furniture. Numbering systems and paperwork procedures can also be improved by standardization.

The fact is that opportunities to derive benefits from standardization are everywhere in industry. But at every point where I have used the term, I would like to prefix it with the word "dynamic." This implies that constant change and advancement will be needed for standards to keep pace with progress. Few opportunities for dynamic standardization present themselves; they must be sought out. They are evasive and frequently hidden behind a screen of paper work, established practice, company policy, entrenched habits, complacency, and preoccupation with current emergencies. Every company needs at least one "standardization oriented" individual to dig, question, analyze, reveal, and act upon opportunities. His salary can be your best investment.

From a talk entitled "Standardization and Electronics Progress" presented at the 9th National Conference on Standards of the American Standards Association, New York, Nov. 1958.

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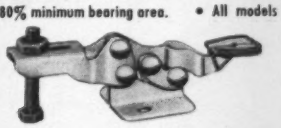

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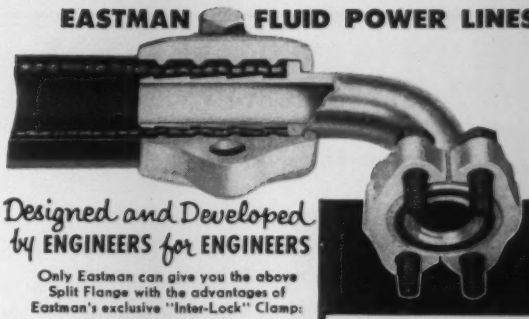

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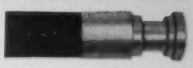

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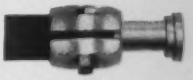

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- Grinding
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FOR THOSE MANUFACTURERS WHO ARE FACED WITH MANUFACTURING PROBLEMS WE OFFER A FREE BULLETIN ILLUSTRATING MANY STAMPINGS WE HAVE PRODUCED FOR MANUFACTURERS AS WELL AS A SAMPLE AND COST SUMMARY OF AN ACTUAL PART. WE ALSO OFFER FREE QUOTATIONS FROM YOUR BLUEPRINTS AT ANY TIME.

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3289 E. 80th Street • Cleveland 4, Ohio

Circle 733 on Page 17

METZGAR NYLO-® BALL TRANSFER

LASTS 10 TIMES LONGER

- UNITS
- TABLES
- STANDS

RESISTS
DETERGENTS
MILD ACIDS
ALKALIES
SALT BRINE
FOOD ACIDS
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METZGAR NYLO-BEARINGS, WHEELS and ROLLERS are available in all Metzgar Conveyors.

Ball units factory pressure-mounted in 3/16" steel base on ¼" x 2" supporting frame on adjustable "H" stands. Height adjustable in 4 ranges from 10" to 50"

Write for prices and specifications.

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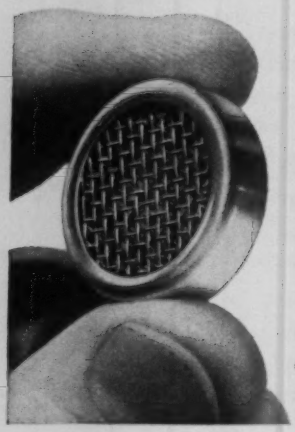
MFRS. OF WHEEL & ROLLER GRAVITY & LIVE ROLLER CONVEYORS • POWER BELT CONVEYORS • SWITCHES • ACCESSORIES

GRAND RAPIDS 4, MICH.

Circle 735 on Page 17

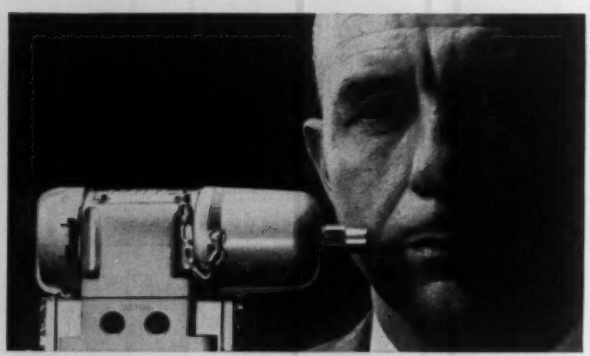
NEW FILTER DISC

screen disc cartridge for service as breather or flame arrester



• A new filter disc incorporating wire cloth screen as filter media is available for application to many types of products. Completely self-contained, for simple adaptation to any product design, the filter disc serves as a breather or can be used as a tank vent flame arrester. Filter media is multiple layers of fine mesh steel or bronze wire screen. Available in 1", 1⅜", 1⅝", 3½" diameters. Write for complete information. **AIR-MAZE CORPORATION**, Cleveland 28, Ohio.

Circle 736 on Page 17



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Consider the advantage of single manifold units—as a standard stock item – which allows you to design and build your own manifolds of from two to ten valves. And with electrical plug-ins the body simply plugs onto the base to complete the wiring. Write for information on the revolutionary 4-way Dual-Seal air valve. ¼", ⅜", ½" port sizes.

MECHANICAL AIR CONTROLS, INC.
10030 Capital, Oak Park
Detroit 37, Michigan
Export Representative: Ad Auriema, 85 Broad St., NYC 4

MAC

Circle 737 on Page 17

are you stuck?

confidential file

Readers with problems concerning systems, equipment, or components for automated operations are invited to outline them to: The Editor, AUTOMATION, Penton Bldg., Cleveland 13, Ohio. Readers having solution suggestions are invited to submit them and should refer to case number and title of the problem involved. Dates shown with suggestions indicate issue in which the problem was presented.

CASE 1774-P

FEEDING BRASS CUP HOOKS

. . . We have not been able to find feeding devices for this item (brass cup hook) because of the entanglement problem. Briefly, our task is to feed this article, thread down, at the rate of 5000 per hour or better. . .

Industrial Finisher

CASE 1773-P

MOTION CONTROL FROM FILM

. . . We are in search of a simple inexpensive system which will provide automatic record playback of motion, with the control signal recorded on a magnetic stripe on motion picture film. Since our system will be used to control the rotation and tilting of a motion picture projector, the only standard we have is whether or not the error is visible to eye. There must be standard components available, and a manufacturer who can make up a system to our specifications. We would not require great power, probably a ¼-hp motor being sufficient. Could you put us in touch with manufacturers who could supply such a system. . .

President

SUGGESTIONS FOR 1647-P (JAN. 1959)

HANDLE SHAPING

. . . We would be very much interested in trying to work out an answer to this problem. It would be necessary for us to have a sketch or print of the wood handle and also the range of sizes, together with an indication of estimated production required. . .

Wm. C. Knapp
Mattison Machine Works

. . . We make automatic sanding machines. We would like some rough and finished samples to determine whether this could be done on a modified version of our Nash Automatic Turning Sanders. . .

A. Kluge
J. M. Nash Co. Inc.

. . . We have built several machines where the problem was finishing hollow and solid knife handles (metal) by means of abrasive belts. Existing belt sanders could probably be used. The method of arriving at the desired motions is by means of elliptical or eccentric gearing and a pneumatic circuit. We would be pleased to work on the problem. . .

Norman S. Feingold

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Single and Double Reels In the Small and Medium Range, for coils of 100 lbs. to 10,000 lbs.

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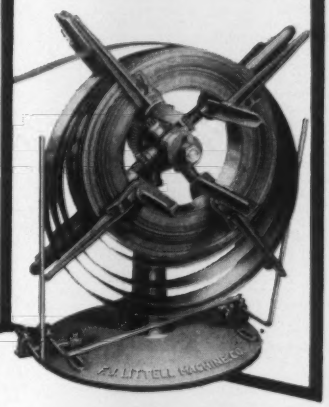

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Circle 738 on Page 17

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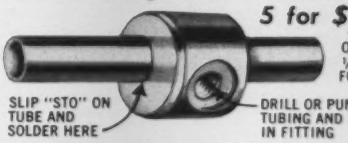

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Circle 740 on Page 17

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LIVE ROLL Conveyor is particularly suitable for transportation, deflection operations or hold back of loads.
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Circle 739 on Page 17

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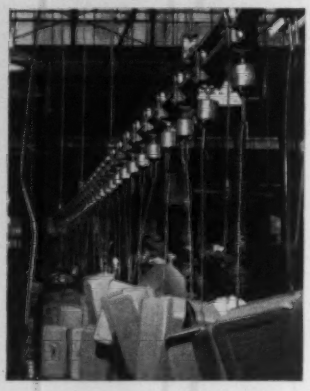

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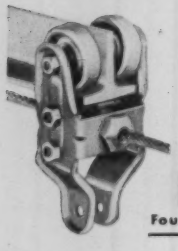

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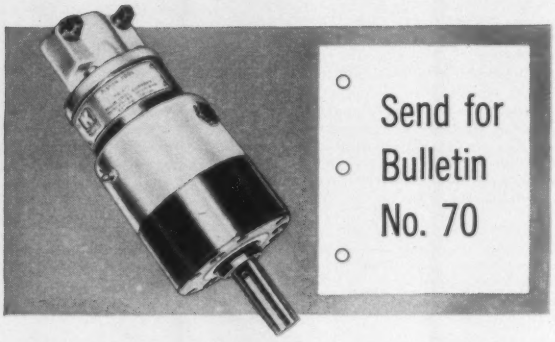

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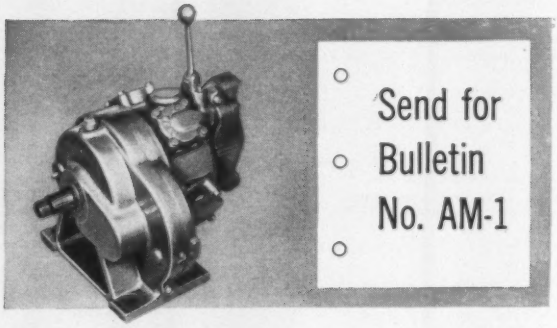

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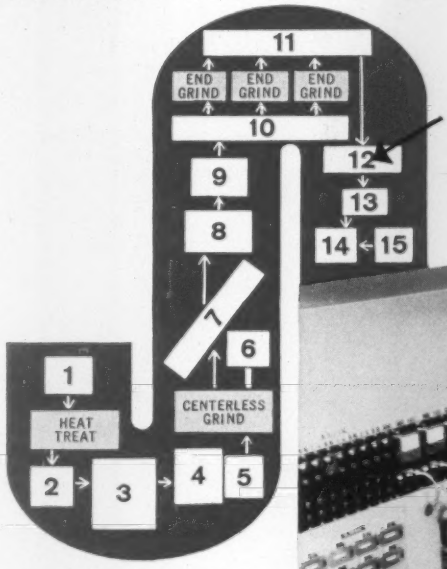

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Taper of skirt
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count

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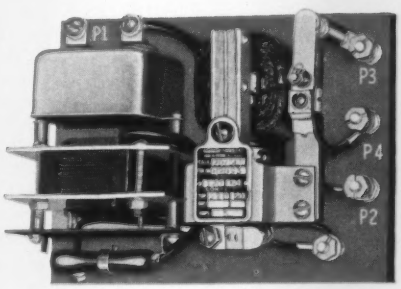

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